T H E U N I V E R S I T Y O F A L B E R T A

RELEASE FORM

NAME OF AUTHOR ...HENRIETTE..E...DURAND.....

TITLE OF THESIS ...An.Examination.of.....

...Bilingual.Information.processing...

...in.the.free.recall.paradigm.....

DEGREE FOR WHICH THESIS WAS PRESENTED .Doctor.of.Philosophy

YEAR THIS DEGREE GRANTED .....1977.....

THE UNIVERSITY OF ALBERTA

AN EXAMINATION OF BILINGUAL INFORMATION PROCESSING IN THE FREE RECALL PARADIGM

BY

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA

FALL 1977

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "An examination of bilingual information processing in the Free Recall paradigm", submitted by Henriette Elizabeth Durand in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

To my Mother and Father

ABSTRACT

This thesis examines the information processing of bilingual synonym and unilingual material in the free recall paradigm. In the first experiment, to provide a test of the validity of the distinction between single and dual stores, two tasks were designed. The objective of the first task was to examine the acquisition of bilingual, synonym and unrelated unilingual information in a multi-trial free recall paradigm, when subjects are free to recall in the language of their choice. The second task was designed to see what effect the learning of the three different kinds of information, unilingual, bilingual and synonym, would have on a delayed recall test.

The findings of the first study indicated that both synonym and bilingual lists were acquired more slowly than the uninlingual lists. A second finding indicated that both bilingual and synonym conditions showed the same proportional loss of information during the 24 hour delayed retention period. Compared to unilingual lists, the retention of bilingual and synonym lists was superior.

The second experiment was designed to investigate the acquisition of bilingual synonym and unrelated unilingual information in a multi-trial free recall paradigm. However, in order to facilitate intralist organization, this experiment included the item and its translation or synonym within a list, rather than alternating the word and its translation or synonym over the five trials. The second task, a 24 hour delayed recall test, was designed to examine whether the three kinds of information would show a difference in the proportional loss of information.

In this study both bilingual and synonym lists were acquired more readily than unilingual unrelated lists. Contrary to the findings of the previous experiment, both the bilingual and synonym conditions showed the same proportional loss of information during the 24 hour delayed retention period as that found in the unrelated unilingual condition.

The third study examined a testing situation in which subjects were presented with unilingual, bilingual and synonym lists. Following the presentation of these lists the subjects who were anticipating one form of a retention test, received another.

The results of this study show that subjects perform in the same way regardless of the material being presented. That is, all three lists showed a significant drop in performance on the unexpected recall test. Further, synonym and unrelated mixed language lists did not differ in performance over all conditions. On the other hand, the performance on the bilingual lists was significantly better than either the synonym or unrelated mixed language lists.

Acknowledgements

I would like to thank Dr. Gerard Kysela, my advisor, for all his support and help which made the development and completion of this thesis possible. I would also like to thank Dr. Stephen Carey for posing the many challenging questions and ideas which contributed to my intellectual growth.

Most of all I would like to thank my parents for their encouragement and understanding.

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CHAPTER I

Introduction

Arsenian (1945) estimates that some 1,500 different languages are employed by the populations of the globe, making bilingualism a widespread phenomenon. Great advantages as well as great disadvantages have been attributed to bilingualism. Some researchers have emphasized such benefits as sharpening the child's mind, extending his mental horizons and making it easier to learn a third language. Others have decried the evil effects of bilingualism which they believe result in mental confusion, inadequate mastery of either language and cultural alienation.

Bilingualism is not a uniform phenomenon. That is, not all bilinguals use the two languages with equal efficiency and the degree of efficiency varies during the life of the same individual. Because of this variability, early experimental approaches attempted to find methods of measuring the degree of bilingualism. However no completely satisfactory method was found and reasearchers began to focus instead on the cognitive processes found among bilinguals.

Initially three problems developed in the area of bilingual (or multilingual) research. Firstly, the assumptions

underlying the theoretical approaches to memory and information processing whether appropriate or not influenced the perception of bilingual memory processes. Secondly, the questions investigated with bilingual subjects lacked a theoretical framework which led to isolated studies investigating disparate issues. Thirdly methodological problems arose due to the previous problems. The most important one: little systematic development and replication of studies; rather many experiments have been single attempts wherein a variety of paradigms have been used, each investigating a different question.

Two pre-theoretical assumptions underlying memory research had an influence on the direction of bilingual research. The first assumption, that memory is divided into temporal stores, resulted in the distinction between long and short term stores; as well as the emphasis on the memory processes of encoding, storage and retrieval. The second assumption which underestimated the difference between nominal and functional stimuli resulted in the emphasis upon the limitations of the memory system.

The separation of memory into temporal stores has resulted in an undue emphasis on the characteristics of the memory structure rather than focussing on memory processes. In relation to bilingual research a question of major importance was whether bilinguals had a single or dual storage system. One hypothesis is that all experiences are coded in common, and each

of a bilingual's languages taps this common store (Dalrymple-Alford, 1968, Nott & Lambert, 1968). The other hypothesis holds that events are coded specifically and separately in the language in which they are experienced (Kolers, 1964, 1963, Tulving & Colotla, 1970). If verbally defined experiences are coded and stored in common then a bilingual's languages appear to act as an independent tag for this common storage, and experiences stored in one language are retrieved and described directly in the other language. Alternatively, if verbally defined past experiences had been tagged and stored in a form specific to the language the individual used to define the experience to himself, a bilingual would have a different store of experiences to refer to for each of his two languages, or would be required to tag a given experience twice, once in each language. It would be impossible then to refer directly to or to retrieve in one language an experience or event tagged in the other.

The second pre-theoretical assumption, which emphasized that the limitations of the memory system were more important than its strengths, resulted in experiments in which the tasks were unreasonably difficult. The system, it is suggested, is of limited capacity, and there are certain points in the system at which these constraints are strongest. Therefore, particular structures are hypothesized at these points implying a temporal sequence, with information being passed through the system from one structure to another (e.g. one primary store to

another). As a result, tasks were made difficult by presenting unrelated meaningless items at a fast rate, instead of giving the subject the opportunity to use the resources at his disposal to examine the material as a meaningful whole (Herriott, 1974). Similarly, in bilingual research, interlingual task demands were often more difficult than intralingual task demands. This is evident in the studies of Kolers (1964,1963), Nott and Lambert (1968), Lambert, Ignatow, Krauthamer (1968) and Tulving and Colotla (1970) which required that the subject recall the presented item in the correct language of presentation, whereas in the unilingual condition the same task demand did not exist. One method of equating the interlingual and intralingual task demands would be to leave the subject free to recall the item in the language of his choice.

One factor that may have influenced the lack of theoretical development of bilingual research has been the tendency among memory researchers to approach the bilingual issue as an interesting minor issue unworthy of investigation. This phenomenon can be seen in the studies of Goggin & Wickens (1971) and Tulving & Colotla (1970). In both these instances the researchers had been investigating theoretical questions of importance to the development of their own theory. Tulving & Colotla (1970) were primarily interested in organizational units whereas Goggin & Wickens (1971) were interested in attribute shifts with the Brown-Peterson paradigm. This same criticism can be made of other

studies in the area. Glanzer and Duarte (1971) for instance, were primarily interested in the differences between short and long term memory, while Yuille, Paivio and Lambert (1969) were interested in noun-adjective imagery.

To date, no theoretical position exists which attempts to explain bilingual information processing and as a result no systematic methodology has developed which would have led to replication and elaboration of a theoretical framework. Another factor influencing bilingual research is the use of paradigms only once. For example, Kolers (1964) used an alphabet inversion task to investigate transfer of skills from one language to another. On the other hand, Young & Webber (1967) used a paired associate task to investigate positive and negative interlingual transfer, as did Kintsch and Kintsch (1969). However, these studies have had little theoretical relationship with one another and no methodological relationships.

A third factor that has had an impact on bilingual research is, that many of the task variables have not had adequate control conditions, thus jeopardizing any interpretation due to the manipulation of the independent variable. Kolers (1964) maintains that cognitive skills obtained through one language are not directly available in the other. He based this position on an experiment in which bilinguals practiced inverting the alphabet in one of their languages and then tested, for transfer of the skill

or practice, to the other. Kolers (1964) found that the alphabet inversion skill did not transfer. To accept this result, as supporting the view that such cognitive operations when learned within one linguistic system remain language specific and are not transferred to the other language of the bilingual, it is necessary to demonstrate that intra-lingual transfer of the skill does take place. Dalrymple-Alford (1967) in a study similar to that of Kolers (1964) found that a practiced skill may transfer both within and across languages and the skill does not remain language specific thus casting some doubt on Kolers' hypothesis.

In another study (Young & Saegert 1966) the task was to learn a serial list which was then either translated and presented in the same order or in a new random order for relearning or in a control list in which the second list items were unrelated to the first. Young & Saegert (1966) found 50% positive transfer for the same order condition and 18% negative transfer for the random order and control condition. However, since the random order and same order were manipulated only between languages, and not within languages, it remains unclear what role language plays in the learning of a translated serial list. The amount of transfer may simply be due to the order variable rather than the language variable.

In summary, one of the major weaknesses of bilingual research has been the absence of a theory which explains bilingual

information processing. A second but no less important limitation has been the dependency of researchers on existing memory models to explain bilingual information processing. The result of this approach has been the investigation of isolated questions bearing little relation to one another. As such three major questions within the following topic areas have been investigated: storage, organization and transfer. The question at issue in storage is whether there are one or two linguistic systems which are psychologically distinct to express a single set of meaning or intentions. The second question of importance is whether language enhances or detracts from the organization of individual items into higher-order units, and lastly whether associations formed within the context of one language can facilitate or interfere with the formation of new associations in a second language.

The present study will attempt to focus upon two of these problems, the separate store sypothesis and the transfer question and, secondly to formulate a consistent conceptual description of bilingual information processing as a result of these investigations.

CHAPTER 2

In bilingual information processing, a question of importance has been whether bilinguals possess one or two stores. Due to the emphasis on the structural nature of information processing, it has been assumed that since a long and short term memory component exists, then it is possible that bilinguals possess two separate memory stores, one for each language. These two stores interact only through translation processes just as short and long term stores are distinct and interact only through rehearsal processes. Thus it is suggested that bilinguals process information in a similar manner to unilinguals with the exception of any extra store in long term memory.

Bilingual Information Processing in Primary Memory

Since primary memory is assumed to favor processing in terms of the physical or phonological characteristics of an item, it has been assumed that primary memory is not affected during the processing of bilingual information because of the semantic features of bilingual information. Kintsch and Kintsch (1969) sypothesized that if subjects are asked to retain a word briefly in memory without extensive processing, then no interference effects between translated word pairs would be expected. In this study subjects learned two sets of lists, the experimental list comprising adjectives with their translations, and the control list: unrelated adjectives. A probe procedure was used and Kintsch and Kintsch (1969) found that the probed lists were

recalled equally well irrespective of experimental conditions. Kintsch & Kintsch (1969) maintained that subjects responded to the sound of the words rather than to their meaning - a characteristic of primary memory storage.

Tulving & Colotla (1970) in a free recall paradigm of unrelated words used the length of intratrial retention interval to measure primary memory. They found that the recall of words from primary memory was identical for unilingual and multilingual lists, which finding supported the premise that the primary component of memory is not affected by bilingual information processing. Glanzer and Duarte (1971) also used a free recall paradigm to investigate the difference between primary and secondary memory with bilingual subjects. In this study, words were repeated in the same language (within-language repetition) or were followed by their translations in the other language (between-language repetition). The distance between the word, its repetition and the number of other words intervening was systematically varied. Glanzer and Duarte (1971) found that between-language repetitions gave higher overall recall than within-language repetitions. This advantage was most noticeable at short distances. Glanzer and Duarte (1971) concluded that there is processing of semantic information for words represented in short term memory and therefore the bilingual short term store is affected during information processing. This position is compatible with that of Kolers (1966) who found similar results in a

comparable experiment.

Single versus Dual Store Hypothesis

Secondary memory is assumed to favor processing in terms of the semantic features of an item. The need to distinguish explicitly between two linguistic forms with the same meaning is a characteristic of bilingual information processing. Therefore it has been assumed that the secondary component is most affected by bilingual information processing. One outcome of this reasoning is to hypothesize that more than one memory store is present in bilingual secondary memory.

Kolers, (1963), using a word association test, maintained that material encoded specifically in one language was not necessarily available in the other language. He found that subjects give different associations to a word in their native language from those they give to its English translation. He concluded that the bilingual had separate encoding routines and storage systems for experiences represented in the two languages. Goggin and Wickens (1971) hypothesized that a change in language will produce almost complete release from interference in the Brown-Peterson paradigm. They found an overall recovery of 68% when language is changed. This finding suggested that the data could be interpreted as support for separate memory stores for each language.

Tulving and Colotla (1970) in their study of single-trial free-recall with unrelated words found that recall performance was highest from unilingual lists, intermediate from bilingual lists, and lowest from trilingual lists. Tulving & Colotla (1970) interpreted their results as being due to an impairment of subjective organization of words across language boundaries and impaired organization of words within a language due to the structure of the multilingual lists. That is, the structure of the mixed language lists interfered with the subject's ability to organize. The implication of this position is that organizational processes which occur in free recall are restricted to the formation of higher order retrieval units made up of items in only one or the other language.

Several studies with single-trial free recall of unrelated words found that bilingual lists did not differ from the recall of comparable unilingual lists. Lambert, Ignatow and Krauthamer (1968) presented bilingual subjects with unilingual lists in each of their languages, and bilingual lists composed of words drawn from both of their languages. One of their bilingual category lists was referred to as discordant since half the words in each category were in language one, and half in language two. For this type of bilingual list, recall was poorer and category clustering was less prominent than in the unilingual category lists.

However, no differences were found between unilingual and bilingual uncategorized lists. Lambert et al. (1968) ascribed their results to the notion that a word is filed several times in the bilingual's memory, once according to each of its distinctive properties e.g. language, semantic context, part of speech, and also as a marker that helps differentiate words within a list, thereby aiding recall.

Dalrymple-Alford (1969) in a study similar to Lambert et al. (1968) used Arabic-English bilinguals in a free recall situation. The subjects were given free recall learning trials with a list of words drawn from two taxonomic categories. Half of the words in each category were in English and half were in Arabic. Dalrymple-Alford (1969) found that lists which were serially organized into language blocks tended to be less well recalled than lists organized into category blocks. He concluded that the main organizational principle in bilingual free recall is one in terms of conjoint category and language membership, and not language or semantic category alone.

Nott and Lambert (1968) came to a similar conclusion. They gave their subjects three different kinds of lists: a randomly ordered category list, without information about the categories; a randomly ordered category list, with the category names given to the subjects in advance; and a

list of words grouped by categories in their presentation, with their category names given. Each kind of list was given in three language conditions: French, English and bilingual. Differences in recall between unilingual and bilingual lists occurred with category but not with non-category lists. This suggests that bilingual category lists were not remembered as well as unilingual ones because the subject had to store the additional information about language once he had semantically decoded the word.

In all these studies subjects have been required to recall in the language of presentation. Due to the increased information demands for the multilingual lists, criterion differences may exist between unilingual and multilingual lists which favor the former and penalize the latter. In addition the reason recall was lowest in multilingual lists was not due to the subject's inability to organize across language boundaries, but because unlike the subjects in the unilingual list the subjects in the multilingual condition were asked to discriminate between the languages at presentation and at recall. However Rose and Carroll (1974) using a mixed language list, encouraged their subjects to guess the language of presentation and found that recalled words were usually in the correct language. This finding would tend to support the notion that mixed language lists and unilingual lists are fundamentally different.

The results of the studies reviewed in this section, do not answer unequivocally the question of whether primary memory is affected during bilingual information processing or whether bilinguals possess one or two stores in secondary memory. In the present study a multi-trial free recall procedure is employed in which language is alternated between trials to eliminate the problems of discrimination at encoding and decoding and to minimize criterion differences. This procedure should identify differences in acquisition between unilingual conditions and bilingual conditions.

Another question being addressed in this study investigates the difference in acquisition among unilingual conditions, bilingual conditions and synonym conditions. Schank (1973, p. 191) maintains that ...

> Any two utterances that can be said to mean the same thing, whether they are in the same or different languages should be characterized in only one way by the conceptual structures ... Thus the conceptual base is responsible for formally representing the concepts underlying an utterance without respect to the language in which that utterance was encoded.

Schank's (1973) view of language understanding is that there exists a conceptual base into which utterances in natural language are mapped during understanding. It follows that translated material and synonymous or paraphrased material should be equivalently represented in the conceptual structures. If so, then it is reasonable to expect that these two types of material would show similar acquisition for bilingual subjects, thus answering the question of single or dual storage.

A delayed free recall test is employed in addition to the immediate free recall test to assess possible differences in delayed retention among the conditions. The use of this paradigm allows for a comparison of learning among the different lists. That is, given that multilingual lists show inferior acquisition compared to unilingual lists, it is possible they would show better retention because they are more difficult to process.

The Free Recall Paradigm

The core methodology of free recall has remained unaltered over the years. This methodology simply modifies serial recall by freeing the subject to recall the input items in any output order. Kirkpatrick (1894) intended the free-recall method to provide a test of memory, rather than associative learning. Kirkpatricks' introductory statement conveys this orientation ... (p. 602)

> A complete act of memory requires that impressions shall be retained, recalled and recognized as familiar and as belonging with certain other impressions.

The emphasis is on storing information (retaining impressions), retrieving information (recalling impressions) and utilizing an inherent organization within memory (belonging with certain other impressions).

Free recall is now probably one of the most frequently employed methodological paradigms in verbal learning research.

Much of the interest in free recall related directly to the method's defining attribute: its permissiveness in allowing discrepancies between input and output orders. The order of input is rarely a direct parroting of the serial order manifested during item input; nor is the recall order likely to be a random permutation of the input order. Rather recall is characterized by the emergence of its own intrinsic organization. Tulving (1962) using a list of unrelated items referred to this process as subjective organization and operationally defined it as the tendency for persons to recall words in the same output order on successive recall trials in spite of re-randomized input across orders of presentation.

Organization may be either primary or secondary in form (Tulving, 1968). Primary organization implies the operation of both short and long term memory systems during free recall, with the short term system mediating the storage and retrieval of information from one part of the list, the recency and primary effect, and the secondary memory system mediating storage and retrieval for the remaining information. Murdock (1962) convincingly demonstrated the generality of these findings across a wide range of conditions. Secondary organization is defined by Tulving (1968) as organization which occurs when the output order of items is governed by semantic or phonetic relations among items or by the subjects prior extra-experimental or intra-experimental acquaintance with

the items constituting a list. Secondary organization offers a means of testing various hypotheses concerning the organizational structure of memory itself, and the manner by which information is stored and retrieved within this structure.

In single-trial free recall a list of items is presented to the subject who is then asked to recall as many of these items as he can in any order. The subject is given credit for every item regardless of order and the output order need not have any prescribed relationship to the order of presentation.

In multiple trial free-recall the subject is given a number of alternating input-output, or study-test phases, each of which constitutes a "trial". The standard procedure employs a different order of items on each of the input phases. This "varied" or random order procedure is supposed to minimize the opportunity for direct associative learning via repeated contiguous occurrence of items. The random order procedure also assures that whatever advantages are attributable to assignment to early and late serial positions are at least partially equalized for the various items. With lengthy lists and multiple trials, increments in free recall are expected to occur through the acquisition of interitem associations (Bousfield, Puff and Cowen, 1964, Tulving, 1962) as well as through the acquisition of context item associations.

The lists in the free recall paradigm are usually categorized or unrelated words. Categorized lists are made up of words that belong to one or more taxonomic categories. For example, a list could contain the following taxonomic categories: animals, vegetables, colors, minerals and musical instruments with words, such as carrots, tomatoes, peas, onions within one of the categories on the list. The categories can be explicitly stated, or can be unstated. An unrelated free recall list contains words that are unrelated i.e. the words within a list do not bear any categorical relationship to one another. For example, butter,ribbon, king, leather and corner would be unrelated words.

In summary, multi-trial free recall emphasizes the importance of clustering and organization during acquisition while single-trial free recall emphasizes the importance of retrieval cues in mediating performance.

Rationale

Some studies propose that bilingual information is acquired differently than unilingual information and therefore bilinguals possess two separate stores in secondary memory (Tulving & Colotla, 1970; Kolers, 1964, 1963). Other studies show that bilingual and unilingual information do not differ in acquisition and therefore bilinguals possess only one store in secondary memory with a language marker to indicate list

membership (Nott & Lambert, 1968; Lambert, Ignatow & Krauthamer, 1968).

In this experiment, to provide a test of the validity of the distinction between single store and dual stores, two tasks were designed. The objective of the first task is to examine the acquisition of bilingual, synonym and unrelated unilingual information in a multi-trial free recall paradigm, when subjects are free to recall in the language of their choice. If as Schank (1973) maintains there is no difference between a translation and a synonym in the conceptual system, then both synonym and translations should behave similarly in this experiment. The second task was designed to see what effect the learning of the three different kinds of information, unilingual, bilingual and synonym would have on a delayed recall test.

METHOD

Subjects:

The subjects, who had not previously been tested, were 46 grade 10 students from J.H. Picard Bilingual High School in Edmonton, Alberta. A bilingual school is defined as a school were 50% of the teaching is done in the French language. The subjects, all students of Social Studies 10, were randomly assigned by computer to two groups of 23 subjects each.

Materials:

The stimuli consisted of 150 unrelated words and their translations, and 100 synonyms taken from Thorndike - Lorge (1944). The only restriction in selecting the words was that the words used were known to the subjects in both the French and English language.

Six list of 25 words each, equated for frequency, were constructed. In all, there were 2 unilingual lists, 2 bilingual lists, and 2 synonym lists (Appendix 1).

Both the synonym and bilingual lists were made up of a token word (e.g. little), with a synonym (e.g. small) and a translation (e.g. petit). This meant that each word chosen for the experiment could be rotated through all conditions (See Appendix 1).

Procedure

Each of the 3 conditions (unilingual, bilingual and synonym) was presented twice to each group in a counter-balanced order (Table 1). In all conditions each 25 item list was presented five times with a new order of presentation on each trial at a rate of 1 word/sec via tape recorder.

The bilingual condition began with either a French or English presentation and alternated between the two languages for the remaining 4 trials. Similarly in the synonym condition the lists alternated between set A and B. This method of presentation means that if Group I heard a synonym list first, then Group II heard the same list of words presented bilingually. This procedure was followed throughout the entire presentation including the unilingual conditions in order to minimize as much as possible the effect of any list differences.

Standard multi-trial free recall instructions were given for each list with the exception that the subjects were told what kind of list they were about to hear, and they were free to recall in the language of their choice for all conditions.

Twenty-four hours later an unanticipated delayed recall test was administered. The subjects were asked to

TABLE 1

Presentation Order

Groups	Lists					
	I Trial 1-5	II Trial 1-5	III Trial 1-5	IV Trial 1-5	V Trial 1-5	VI Trial 1-5
I	Synonym	Bilingual	Unilingual French	Bilingual	Synonym	Unilingual English
II	Bilingual	Synonym	Unilingual English	Synonym	Bilingual	Unilingual French

write down as many words as they could remember in any order from all of the lists they had heard on the previous day. Again they were free to recall the words in the language of their choice.

Results and Discussion

Both groups were compared to see if there were any group differences in acquisition of the different lists. Analysis of variance of means on trial 5 and over all trials (see Appendixes 3.1, 3.2) indicated that there were no significant group differences. Since there were no group differences the data were pooled and all further analysis are on the pooled data.

Recall scores for the four lists are given in Table 2. Scores are expressed as percentage correct recall. In a typical multi-trial free recall situation increments are expected to occur over trails. Analysis of variance showed that the main effects for trails for all lists was significant F (4,1007) = 207, $p < .001$ (Appendix 4.1). As can be seen from Figure 1 with the exception of the synonym lists, the performance in the remaining three lists improved consistently over the five trials. Although the synonym list did not improve consistently over the five trials nevertheless it did show some improvement. The saw tooth effect of the synonym list could be due to the fact that on trial I the

TABLE 2

Proportion of Words Recalled, Trials 1-5 and Delayed Recall for Each List

Lists	I	II	III	IV	V	Delayed Recall	Difference between Trial 5 and Delayed
Unilingual English	.25	.38	.45	.49	.54	.30	.24
Unilingual French	.27	.36	.43	.44	.47	.18	.29
Bilingual	.28	.32	.38	.42	.44	.30	.14
Synonym	.28	.26	.37	.35	.38	.22	.16

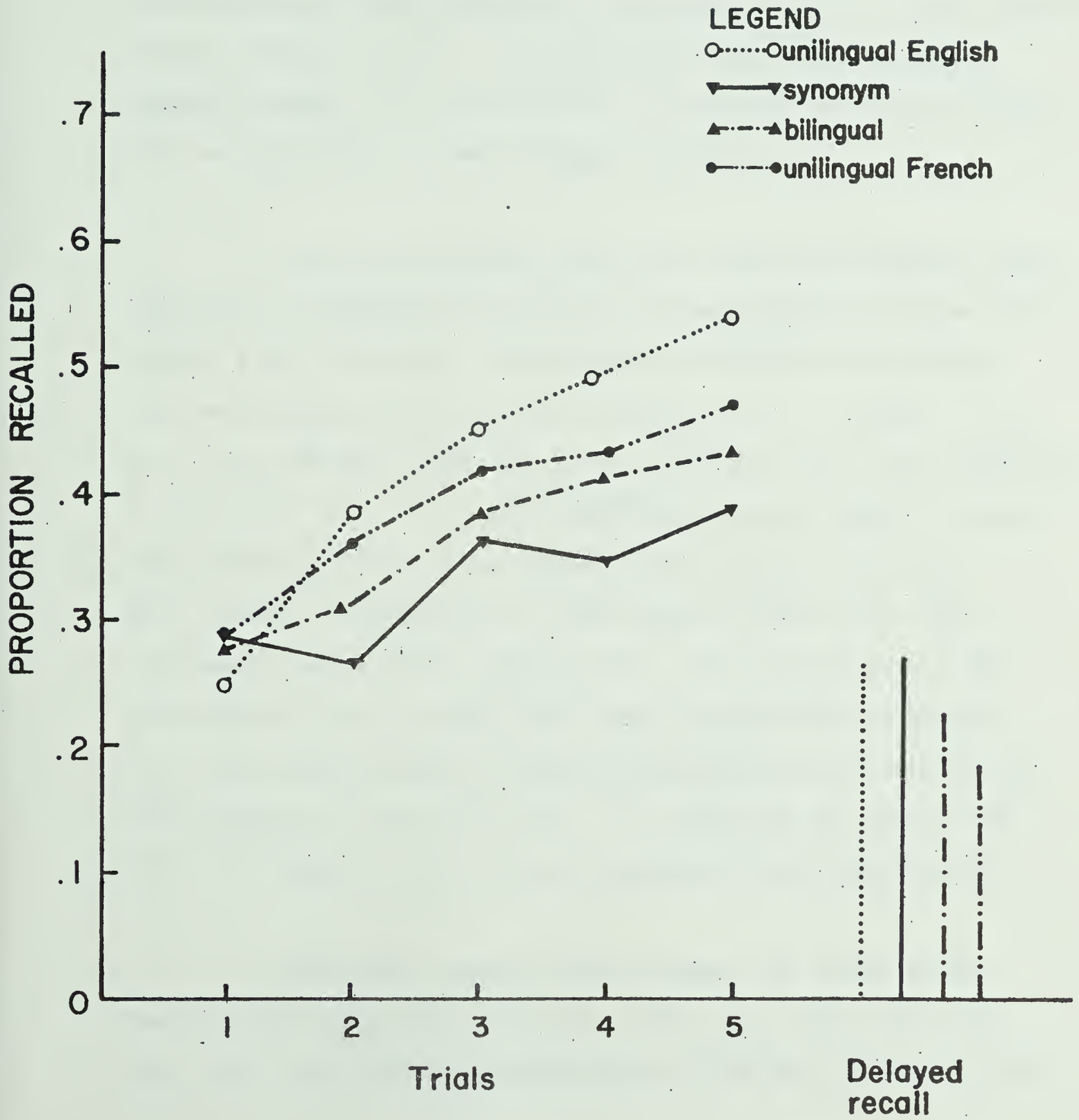

LEGEND
unilingual English
synonym
bilingual
unilingual French
PROPORTION RECALLED
.7
.6
.5
.4
.3
.2
.1
0
1
2
3
4
5
Trials
Delayed recall

FIGURE 1

subjects heard 25 words, while on trial II they heard 25 synonyms of the previously presented words. Although the same condition existed in the bilingual lists (i.e. on trial I subjects heard 25 words, while on trial II they heard 25 translations of the previously presented words) the same learning effect did not occur. It is possible that switching languages between lists created less interference, thus facilitating acquisition in the bilingual condition.

One of the initial questions asked was whether there would be a difference in the rate of acquisition for the different kinds of lists: unilingual, bilingual and synonym. The main effects for lists was significant F (3,1007) 72.7 $p < .001$ and the trials by list interaction was also significant F (12,1007) 9.9, $p < .001$ (Appendix 4.1,4.2) Figure I shows that the English list was acquired most easily over the five trials, followed by the unilingual French list, the bilingual list and the synonym list. The interaction indicated that by the second trial both the English and French list had surpassed the bilingual and synonym list, which was not evident on the first trial. In addition, by the second trial the English list had also surpassed the French list.

Individual comparisons of means for lists using Duncan's Multiple Range statistic (Winer p. 185) indicated that the lists differed significantly from one another; the

performance of the English list was greater than the French list which was greater than the bilingual list which in turn was greater than the synonym list (Appendix 6.1).

Trial 5 and Delayed Recall

The Trials X List interaction is used to assess the relative amounts of loss for the three kinds of lists (bilingual, synonym and unrelated) during the 24 hour delay interval. If the interaction is significant this indicates that information was not lost at the same rate for the different lists. If, on the other hand the interaction is not significant, then information was lost at the same rate for the different lists.

Analysis of variance for Trial 5 and Delayed Recall showed that the Trials X List interaction was significant. (App.5). F (3,3) = 19.6 < .001 , Duncan's Multiple Range statistic, shows that the difference between the bilingual and synonym condition was not significant (see Appendix 6.2). However both lists differed significantly from the English list and the French list between Trial 5 and delayed recall. Although each list showed a different acquisition rate both the synonym and bilingual list show the same proportional loss over time. This loss was significantly less than that found in the unilingual situation.

The findings of this study indicated that both synonym and bilingual lists were acquired more slowly than the

unilingual lists. A second finding indicated that both the bilingual and synonym conditions showed the same proportional loss of information during the 24 hour delayed retention period.

In this study the amount learned was not measured by continued training on successive lists until a common criterion was reached. According to Lockhart, Craik and Jacoby (1975) one alternative approach which was followed in this study, would be to equate lists on the number of exposures or study time rather than on a performance criterion. However Lockhart, et al. (1975) maintain that equating study time is not a totally satisfactory solution since there are still likely to be differences in the particular operations performed as a function of learning to learn, even though study time is equated. That is, learning to learn can be seen as the result of a reduction in the number of operations performed. Words in earlier lists are dealt with more extensively in order to meet the same performance criterion as words in later lists. For items presented during later trials, dimensions or attributes that are common can be given directly from memory and require little new processing.

The inferior acquisition of multilingual lists has been attributed to the lowered accessibility of words from multilingual lists due to the impaired organization into higher order units of individual list items (Tulving and Colotla,1970).

They maintained that this problem could be eliminated under conditions where retrieval of list words is less dependent upon intralist organization; that is, under conditions where within-language organization is less affected by the composition of the list.

While this view can account for the differences in acquisition perfromance between bilingual and unilingual lists, it cannot account for the inferiority of synonym acquisition. Thit is, since the subject was not required to discriminate between languages at recall in the synonym condition, the lowered performance on this list cannot be due to retrieval strategies alone. Since bilingual lists were acquired more readily than synonym lists it would also indicate that the unique composition of both bilingual and synonym lists prevents a fair comparison between these lists and the unilingual lists.

It may be suggested that recall depends on the form of the item's initial encoding, and a failure to recall might just as well be viewed as a consequence of inappropriate initial coding as due to an inadequate retrieval cue (Lockhart, Craik & Jacoby, 1975). An extension of this position would hold that in the unilingual condition where the same test is heard five consecutive times, the stimulus becomes highly practiced or expected and therefore it is analyzed more readily and by fewer operations resulting in an impoverished memory trace, thus supporting the notion than when the

stimulus is expected or commonplace few new features need to be noted to resolve cognitive ambiguity. However, when events occur in new groupings, or demand different responses, as in the bilingual or synonym condition, then new features are needed to establish a durable memory trace. The deeper and more elaborately a stimulus is analyzed by the perceptual system, the richer and more detailed will be the memory trace (Lockhart, Craik & Jacoby, 1975). First the physical and structural features of the stimulus are analyzed, then the stimulus is subjected to progressively more elaborate semantic analysis. In order to establish a semantic-associative relationhip between the stimulus items, the bilingual and synonym lists required more semantic analysis than did the unilingual lists. If the durability of the memory trace is a function of the analyzing operations, then the more elaborate processing of the bilingual and synonym information led to better retention which was evident in the delayed recall situation.

In summary this study has shown that inferior acquisition of bilingual lists is not solely due to an inability to organize information across languages since synonym lists were acquired even less well than bilingual lists. This study also indicates that the nature of the lists may interfere with optimal acquisition and that the processing of bilingual and synonym lists may be somewhat different from that of unilingual lists. However once processed bilingual and synonym lists show better retention compared to unilingual lists.

CHAPTER 3

Tulving and Colotla (1970) in their study of single trial free recall suggested that the problem of inferior acquisition of bilingual lists could be eliminated under two conditions. These conditions are firstly, where retrieval of list words is less dependent upon intralist organization and secondly, under conditions in which within-language organization is less affected by the composition of the list. Similarly, Nott & Lambert (1968) and Dalrymple-Alford (1968) found that bilingual categorized word lists were less well recalled than unilingual categorized word lists, thus supporting the notions that within language organization is affected by the composition of the list. However, in this study, both synonym and bilingual lists demonstrated a similar performance, thus suggesting that the retrieval of list words is dependent upon intralist organization and alternating the two kinds of lists between trials may interfere with intralist organization.

In order to facilitate intralist organization, this experiment will include the item and its translation within a list, rather than alternating the items over the five trials: the same procedure will be followed with the synonym

condition. Thus during the experiment a subject will hear 15 words and their translations or synonyms on each trial. In addition the subjects will also hear an unrelated unilingual list.

Rationale

It is possible that, when a word and its translation or a word and its synonym are included within a list, intralist organization will be facilitated. The objective of this experiment is to investigate acquisition of bilingual, synonym and unrelated unilingual information in a multi-trial free recall paradigm. In order to facilitate intralist organization, this experiment will include the item and its translation or synonym within a list, rather than alternating the word and its translation or synonym over the five trials. Thus during the experiment a subject will hear 15 words and their translations or synonyms on each trial.

Lockhart, Craik & Jacoby (1975) maintain that when the stimulus becomes highly practiced or expected, it is analyzed more readily and by fewer operations resulting in an impoverished memory trace. It is possible that when the word and its translation or synonym are included within a list, the list will be acquired relatively easily because of intralist organization features. A possible outcome would be that both bilingual and synonym information would show the same proportional loss of information on a 24 hour delayed

recall test. The second task, a 24 delayed recall test, was designed to examine whether the three kinds of information would show a difference in the proportional loss of information.

Method

Subjects:

The subjects, who had not previously been tested, were 86 first year education students in the faculty of Education, and the bilingual faculty (Collège Universitaire Saint-Jean) at the University of Alberta in Edmonton, Alberta. The subjects were tested in three different groups, two bilingual groups and one unilingual group. The subjects were not randomly assigned to groups rather they were tested as members of the section of educational psychology to which they belonged.

Materials:

The stimuli consisted of 120 unrelated words, 30 translations and 30 synonyms taken from Thorndike-Lorge (1944).

Four lists of 30 words each, equated for frequency were constructed. In all, there were 2 unilingual lists, 2 bilingual lists and 2 synonym lists (Appendix 7).

Both the synonym and bilingual lists were made up of a token word (e.g. little) and a synonym (e.g. small) or a translation (e.g. petit) within a list . See Appendix 7.

Procedure:

Two of the 3 conditions (unilingual, bilingual and synonym) were presented twice to each group in a counterbalanced

TABLE 3

Presentation Order for Group I Bilingual and Unilingual Lists

LISTS			
I	II	III	IV
Trial 1-5	Trial 1-5	Trial 1-5	Trial 1-5
Bilingual	Unrelated Unilingual	Bilingual	Unrelated Unilingual

TABLE 4

Presentation Order for Group II, Synonym and Unrelated Lists

LISTS			
I	II	III	IV
Trial 1-5	Trial 1-5	Trial 1-5	Trial 1-5
Unrelated Unilingual	Synonym	Unrelated Unilingual	Synonym

TABLE 5

Presentation Order for Group III, Synonym and Unrelated Lists

LISTS			
I	II	III	IV
Trial 1-5	Trial 1-5	Trial 1-5	Trial 1-5
Synonym	Unrelated Unilingual	Synonym	Unrelated Unilingual

order (Tables 3,4,5). In all conditions each 30 item list was presented five times with a new order of presentation on each trial at a rate of 1 word/sec via tape recorder.

Standard multi-trial free recall instructions were given for each list with the exception that the subjects were told what kind of list they were about to hear, and they were free to recall in the language of their choice for all conditions.

Twenty-four hours later an unanticipated delayed recall was administered. The subjects were asked to write down as many words as they could remember in any order from all of the lists they had heard on the previous day. Again they were free to recall the words in the language of their choice.

Results and Discussion

Recall scores for each group are given in Tables 6,7,&8. Scores are expressed as percentage correct recall. A separate analysis of variance was performed for each group to assess the difference in acquisition over the 5 trials for the different kinds of lists (see Appendixes 9.1,9.2,9.3).

The main effects for trials and lists were significant for Group I : F (4,198) = 174.2, $p < .001$ and F 1,198= 333.6, $p < .01$ respectively. The Trial X List interaction was not significant F (4,198)= 1.9 $p > .11$. The bilingual list was

TABLE 6

Proportion of Words Recalled, Trials 1-5 and Delayed Recall for Each List, Group 1

	Trials						
Lists	1	2	3	4	5	Delayed Recall	Difference between Trial 5 and Delayed Recall
Bilingual	.34	.47	.57	.63	.67	.26	.41
Unilingual	.23	.32	.40	.47	.50	.13	.37

TABLE 7

Proportion Of Words Recalled, Trials 1-5 and Delayed Recall for Each List Group II

	Trials						
Lists	1	2	3	4	5	Delayed Recall	Difference between Trial 5 and Delayed Recall
Synonym	.37	.44	.54	.56	.66	.22	.44
Unilingual	.34	.40	.50	.52	.56	.19	.37

TABLE 8

Proportion of Words Recalled Trials 1-5 and Delayed Recall for Each List Group III

	Trials						
Lists	1	2	3	4	5	Delayed Recall	Difference between Trial 5 and Delayed Recall
Synonym	.30	.43	.52	.56	.63	.30	.33
Unilingual	.23	.33	.39	.44	.45	.13	.32

acquired more readily than the unilingual unrelated list but both show the same rate of acquisition (Figure 2).

Group II showed a significant main effect for trails and lists: $\underline{F}$ (4,234) = 115.2, $p < .01$ and $\underline{F}$ (1,234) = 12.7, $p < .001$ respectively (Figure 3). There was a significant Trials X List interaction $\underline{F}$ (4,234) = 6.1 $p < .01$ which indicated that while the acquisition of synonym and unrelated lists increased over trails, they do not show the same rate of acquisition.

Group III showed a significant main effect for trials and lists: $\underline{F}$ (4,333) = 335.1, $p < .001$ and $\underline{F}$ (4,333) = 9.6, $p < .001$ indicating that while the acquisition of synonym lists increased over trails, they do not demonstrate the same rate of acquisition. (Figure 4).

Trial 5 and Delayed Analysis

The Trails X List interaction is used to assess the relative amounts of loss for the three kinds of lists (bilingual, synonym and unrelated) during the 24 hour delay interval. Analysis of variance Summary tables are included in App. 10.1, 10.2 & 10.3 Analysis of variance for Trail 5 and Delayed Recall showed that the Trails X List interaction was not significant for the three groups, I, II and III: $\underline{F}$ (1,66) = 1.4, $p > .23$, $\underline{F}$ (1,78) = 1.8, $p > .17$ and $\underline{F}$ (1,75) = .07, $p > .78$ respectively.

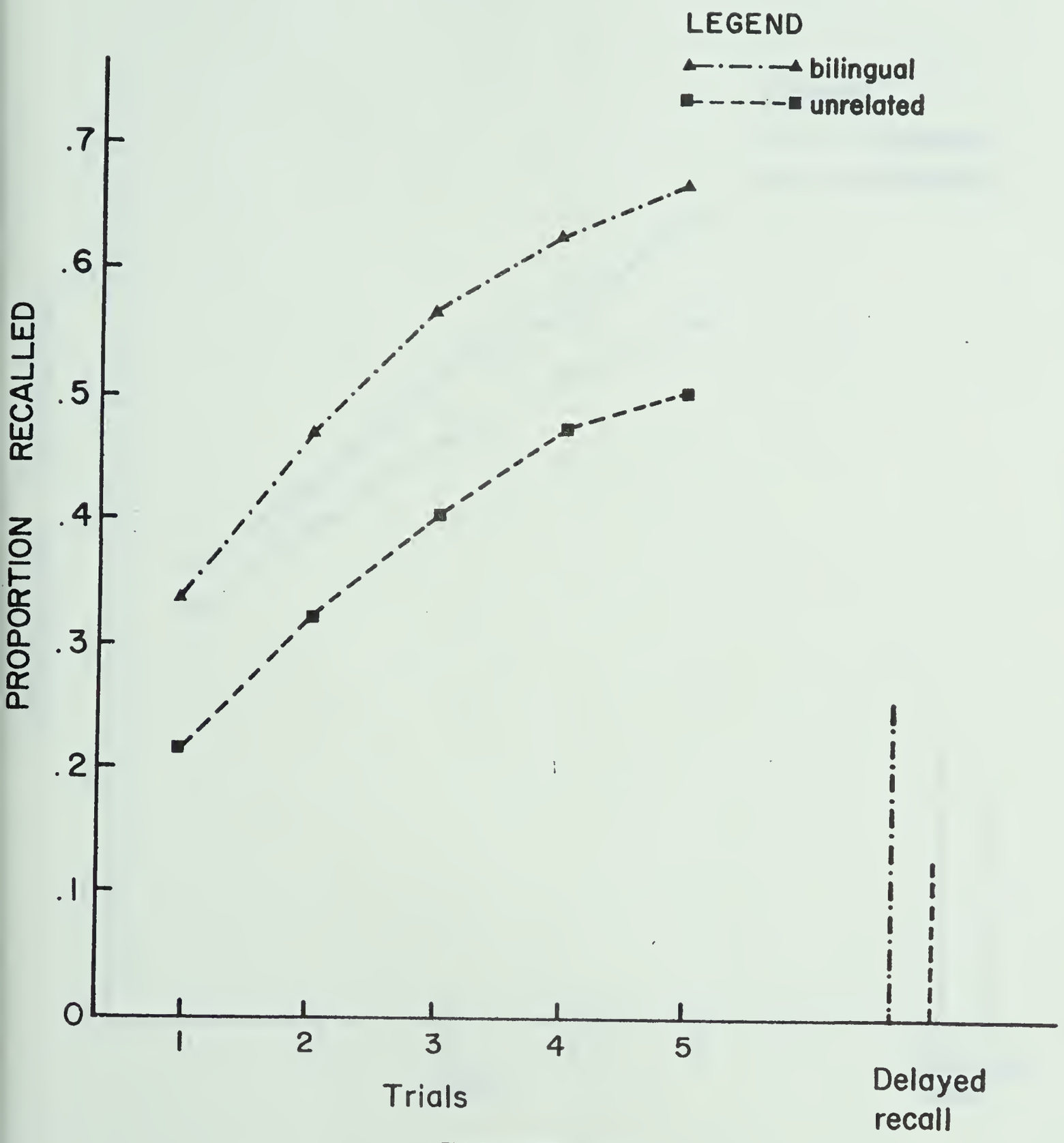
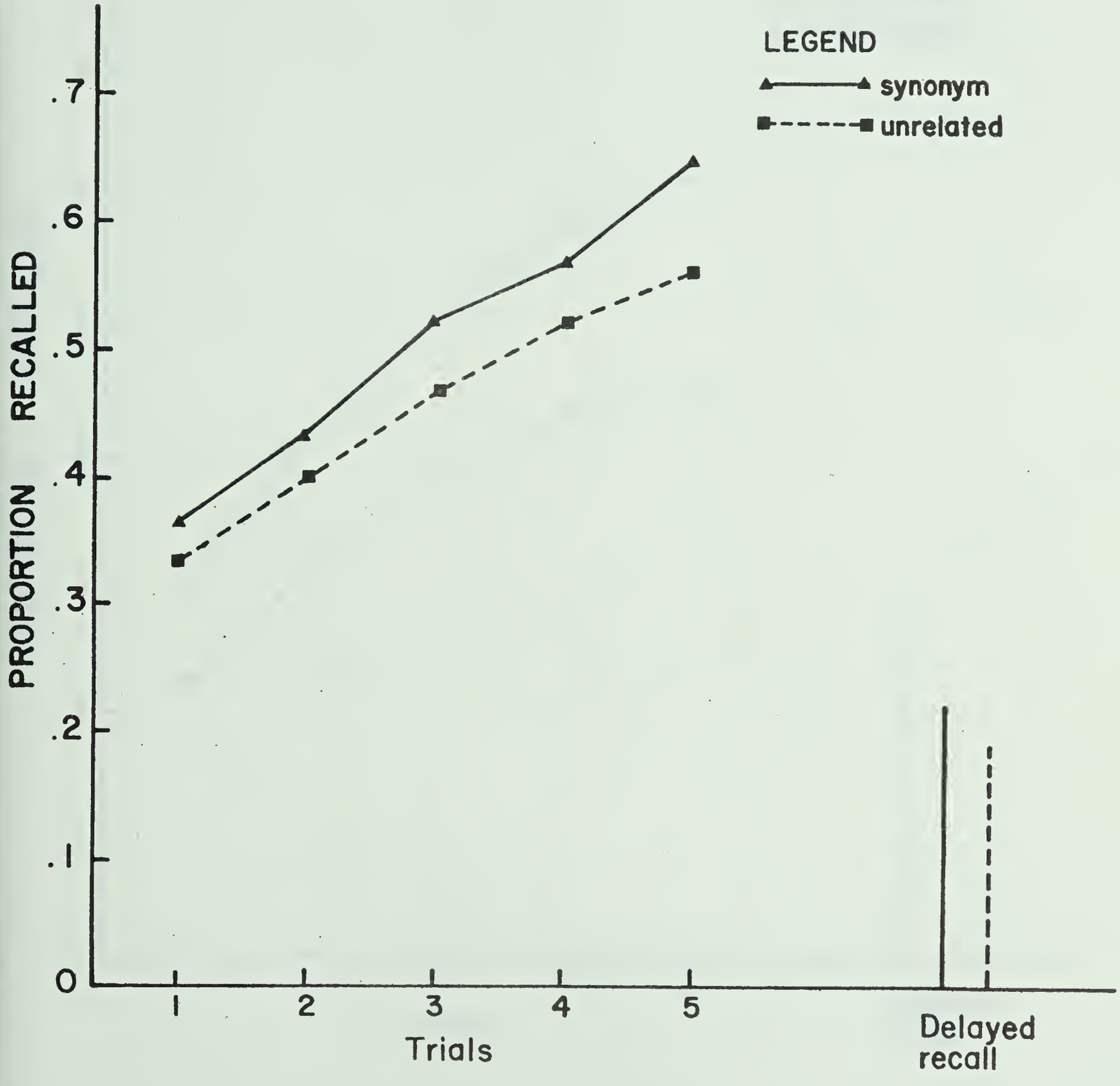

LEGEND
bilingual
unrelated
PROPORTION RECALLED
.7
.6
.5
.4
.3
.2
.1
0
1
2
3
4
5
Trials
Delayed recall

FIGURE 2


LEGEND
synonym
unrelated
PROPORTION RECALLED
.7
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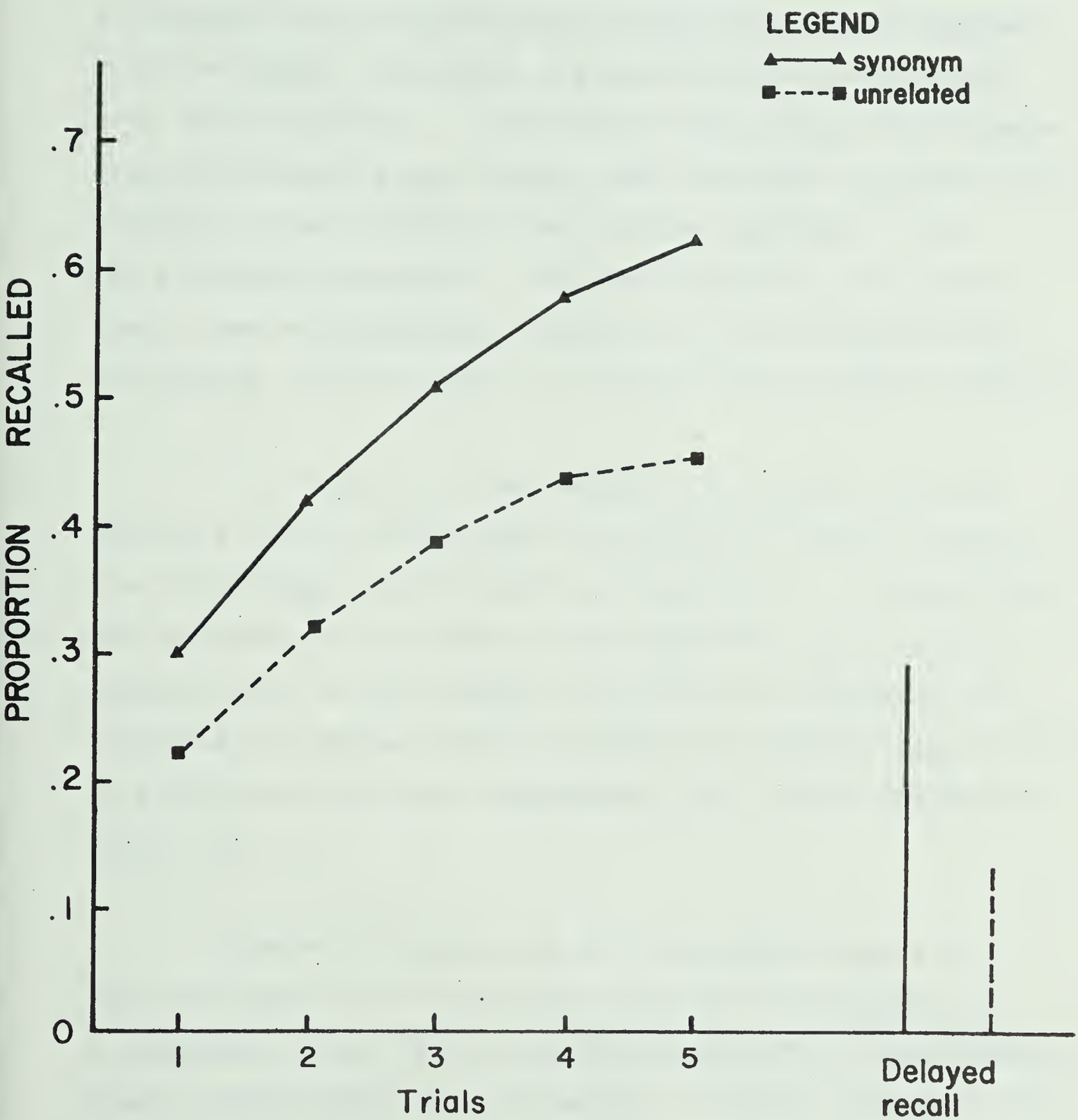
2
3
4
5
Trials
Delayed recall

FIGURE 3


LEGEND
synonym
unrelated
PROPORTION RECALLED
.7
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.4
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.2
.1
0
1
2
3
4
5
Trials
Delayed recall

FIGURE 4

As in the previous experiment the dependent variable of interest was the acquisition of different kinds of information (unilingual, bilingual, and unrelated) in a multi-trial free recall paradigm. In this study both bilingual and synonym lists were acquired more readily than unilingual unrelated lists. Contrary to the findings of the previous experiment, both the bilingual and synonym conditions showed the same proportional loss of information during the 24 hour delayed retention period as that found in the unrelated unilingual condition.

The above result does support the position taken by Tulving & Colotla (1970) that the problem of inferior acquisition of bilingual lists could be eliminated in a condition where the retrieval of list words is less dependent upon intralist organization. In this study, the lists were constructed and presented in a manner that facilitated the intralist organization of synonym and bilingual information, thus leading to superior acquisition.

However the results of the two present studies do not lend support to the hypothesis that the two languages of a bilingual can be seen as being representative of two different memory systems which exist in relative isolation from each other and interact only through translation processes. According to Kolers (1963) translation processes are an additional step required during processing. This position would predict that mixed

language conditions interfere with optimal organizational units across languages in different memory stores and therefore bilingual lists should show inferior acquisition compared to unilingual lists. Interference with optimal organization would also be a factor in the second experiment due to the additional time needed to process the word and its translation even though both were present in the same list. Since both bilingual and synonym lists behaved similarly in the two experimental conditions this position does not adequately explain the results. Several interpretations are possible.

First, it is possible that the results of both experiments are due to the problem of comparing unrelated words with either synonyms or translations. It could be argued that a word and its translation or a word and its synonym are like "mini categories". That is, there is an obvious semantic relationship between the pair which does not exist between unrelated words. This semantic relationship should facilitate learning and therefore bilingual and synonym information should be acquired more readily. However, in the first experiment the results could be explained by the increased number of items to be learned in the bilingual and synonym condition. It could be argued that subjects had to learn 50 items in these conditions compared to 25 items in the unrelated unilingual condition thus leading to a slower rate of acquisition. In the second experiment rather than having to master twice as many items in the synonym and bilingual conditions,

subjects only had to master 15 items in these two conditions. That is, these 15 items acted as cues for retrieving the remaining 15 items thus leading to better acquisitional performance for the bilingual and synonym lists. Since the same advantage was not present in the unrelated unilingual lists it was not acquired as readily.

The differences in performance for the bilingual and synonym lists in the delayed conditions cannot be due only to the difficulty in comparing lists. Since in the second experiment these lists were acquired more readily than the unilingual lists, they should have shown superior retention during the delayed recall interval. However both lists showed the same proportional loss of information as the unrelated unilingual lists. This finding does not support the results of the previous study wherein bilingual and synonym lists showed less loss of information compared to the unilingual lists during the delay recall interval. Since in both studies bilingual and synonym information seem to share similar properties,another interpretation seems more appropriate.

Levels of Analysis

Traditional information-processing models of memory were primarily concerned with structural aspects of memory. The most common research interests were the characteristics associated with the various structures. As a result, memory

theory focussed on the distinguishing features of short and long term memory. Primary memory was assumed to have a limited capacity, both in terms of amount of material and time of retention, while secondary memory has an essentially unlimited capacity. Secondly, the two structures are assumed to differ in the type of coding which is applied to the information they contain. Primary memory is assumed to favor coding in terms of the physical or phonological characteristics of an item, whereas secondary memory favors coding in terms of meaning. Thirdly, the two structures are assumed to differ in the way items are lost or forgotten. Primary memory loses items because of the overloading effect, secondary memory because of interference from other items.

Craik & Lockhart (1972) rejected the view of memory which postulated several specific and discrete systems. They argue that empirical estimates of capacity vary widely, and that under various conditions coding can be phonemic, semantic, orthographic, associative or iconic. In addition, the retention characteristics seem quite variable. Craik & Lockhart noted a range of estimates of persistence of visual features from 0.5 sec. to 25 sec.

According to Craik & Lockhart (1972) analysis proceeds through a series of sensory stages to levels associated with matching or pattern recognition and finally semantic association stages of stimulus enrichment. In this model, incoming stimuli

go through a number of stages of analysis. Initial analyses focus on physical or structural features whereas later or deeper analyses focus on cognitive or semantic features. The persistence of the memory trace depends upon the depth, or level of processing; the deeper, richer, or more elaborate the processing, the more persistent the trace. In addition to this basic memory system, Craik & Lockhart (1972) suggest a way of retaining information by the maintenance of processing at one level. This continued processing prolongs an item's accessibility, but does not necessarily lead to formation of a more durable memory trace. Furthermore this maintenance processing is distinct from elaborative processing which leads to the formation of richer traces and therefore improved memory performance.

> Elaborative processing enables the subject to retrieve the to-be-recalled item by providing features or attributes to distinguish it from other related but not-to-be-recalled items. Items may not only be elaborated by being coded in terms of the number of attributes which the subject extracts, they may also be elaborated by features being added to them. Thus elaborative processing makes material more distinctive and therefore more easily retrieved(Craik & Tulving, 1975).

It could be argued that the different performance of the bilingual and synonym information in the two testing

situations is the result of different processing. In the first experiment, presenting the item and its translation or synonym on alternate trials made the material distinctive from the unilingual information. This style of presentation perhaps because of its novelty required that more features be noted to establish a more durable memory trace, thus leading to a slower rate of acquisition for these lists. On the other hand, in the second experiment presenting the item and its translation or synonym within a list is not a novel approach. Furthermore, this manner of presentation would require less processing than in the previous experiment, resulting in an impoverished memory trace.

It could be argued therefore that the differences in performance for the bilingual and synonym information both on acquisition and on delayed recall are caused by the difficulty in matching items. That is, in the first experiment, in order to establish semantic-associative relationships between the stimulus items, the bilingual and synonym lists required that more features be matched. This "deeper" processing is not evident during acquisition but becomes noticeable during delayed recall, resulting in less loss of information. This same difficulty was not present in the second experiment because the stimulus items could be matched easily within the lists thus leading to less processing or analysis of material and more loss of information during delayed recall.

In summary, the present two studies have shown that both bilingual and synonym information demonstrate similar properties under similar testing conditions. This finding would tend to negate the position that the performance of bilingual information is due to the existence of separate memory stores for each language. The results of these two studies tend to support Schank's (1973) view that there exists a conceptual base for representing the concepts without regard to the language.

CHAPTER 4

The levels of processing orientation emphasizes the processes operating within existing cognitive structures rather than the structures themselves. In this view, the memory trace is not conceptualized as unitary, rather it is viewed as a collection of attributes. These attributes may include physical, associative, semantic or other properties of the stimulus. These attributes are encoded in the representation of the stimulus item, therefore one of the major features of the levels of processing approach is the emphasis it places on encoding. According to Craik & Lockhart (1972) encoding processes are influenced by task demands, familiarity or novelty of stimulus materials and by expectations about the type of retention test anticipated. This means that a form of coding may be selected to suit the specific task or learning situation. This notion is based on the premise that what is stored in memory is a function of the situational or task demands and optimal performance may occur when subjects activate the appropriate control processes for a given task (Carey & Lockhart, 1972).

Control processes:

One implicit assumption in the levels of analysis position is that the processing and transmission of information is controlled or regulated by cognitive input provided by the

subject himself. By means of such control processes subject-selected items in a stimulus input sequence may receive more rehearsal time and effort than other items in the sequence. Control processes may serve to implement various storage and retrieval strategies for eventual recovery of information from memory. An important objective of researchers is to test the operation of these control processes by manipulation of experimental variables. The most common means of accomplishing this objective is through the use of differential instructions to subjects. The instructions emphasize the use of particular strategies for encoding information. Preparation for a test may necessitate the study of information at several different levels. If subjects can anticipate the form of the impending test they are free to focus their study on required information that the test does not provide. The result is a study strategy that maximized encoding strategies which facilitate the optimal retrieval of information. In this procedure, subjects are given practice at either recognition or recall retention test, and are unexpectedly tested by the alternate form of test.

Tversky (1973) studied recall and recognition differences using pictorial stimuli. Knowledge of type of test was advantageous for recognition but not for recall. When Tversky provided subjects with both knowledge of type of test and specific encoding strategy,higher levels of recall were achieved

by the group expecting recall compared to the group expecting recognition. Tversky concluded that subjects perform better on a retention test of which they have been informed and recognition is enhanced by encoding which integrates the details within each item while recall is enhanced by encoding which interrelates the items of a list.

Griffiths (1975) compared two incidental orienting tasks, one encouraging organizational processing and one encouraging imagery processing, with two intentional orienting tasks. The orienting tasks were ones in which subjects were prepared for either a recall or a recognition test. He concluded than an orienting task requiring the imagery elaboration of individual items was highly effective for a recognition list, and orienting tasks fostering organizational processing were optimal for a free recall test.

Previous studies have failed to find unequivocal support for the operation of control processes. Loftus(1971) found better recall performance in pure recall trial blocks than in blocks where recall and recognition trials were randomly mixed, and when the subjects were not forewarned of the test type. Carey & Lockhart (1972) found superior recognition for subjects anticipating a recognition test, but the same finding did not emerge when subjects were expecting a recall test. Jacoby (1973) also failed to find differences in free recall for groups anticipating either recognition, cued recall,

or free recall test. In Jacoby's study knowledge of type of test facilitated only the performance of subjects anticipating a cued recall test. Cued recall apparently facilitated the use of a processing strategy optimal for both recall and recognition tests.

In summary, the existence of control processes that facilitate either recall or recognition have not been clearly demonstrated. Tversky (1973) and Griffiths (1975) provide the clearest evidence for the operation of control processes specific to recall or recognition. These findings suggest that providing knowledge of test type is not sufficient for optimal encoding.

Rationale

Craik & Tulving (1975) extending the levels of processing position, maintain that factors such as study time, number of repetitions, recency, intentionality of the subject, intralist similarity and so on are not crucial for the subject's performance in acquisition, retention, transfer and retrieval of information. They maintain that memory performance depends on the elaborateness of the final encoding and that the memory trace may be considered to be the record of encoding operations carried out on the stimulus materials. The function of these operations is to analyze and specify the attributes of the stimulus. However, memory performance cannot be considered

simply a function of the number of encoded attributes. The qualitative nature of these attributes is also critically important. That is, the greater the number of features, particularly deeper semantic features, the more elaborate the memory trace. Therefore, the processing of bilingual and synonym lists should be the same as an unrelated mixed language list, because a levels of processing view would predict a performance based on encoding features rather than on any intralist similarities. On the other hand, if as Griffiths (1975) and Tversky (1973) maintain,categorization and inter-relationships among the items are crucial for better recall then in a testing situation where subjects are anticipating a recall test and receive a recall test, a synonym or translation list condition should show better overall performance than an unrelated list condition because of the categorization possibilities that are inherent within these lists.

Method

Subjects:

The subjects, who had not previously been tested, were 100 first year education students in the faculty of Education and the bilingual faculty (Collège Universitaire Saint-Jean) at the University of Alberta in Edmonton, Alberta. The subjects were tested in three different groups, two bilingual groups and one unilingual group. The subjects were not randomly assigned to groups rather they were tested as members of the section of educational psychology to which they belonged.

Materials:

The stimuli consisted of 300 unrelated words; 120 words and their synonyms; 120 words and their translations; and 120 words to be used for lures in the two alternative forced choice recognition test (2 AFC). The lists were equated for total frequency according to the norms of Kucera and Francis (1967). As in the two previous studies the only restriction in the selection of words was that the words used were known to the subjects in both the French and English language.

Twelve lists of 60 items each were constructed: 4 lists consisted of 60 unrelated words, half in French and half in English; 4 lists consisted of 30 words and their synonyms and 4 lists consisted of 30 words and their translations. The words were randomly assigned throughout the lists, however

the lists were constructed to minimize the length of runs of words in the same language (Appendix 11). This method permitted 4 lists to be presented to each group, with a parallel set of 3 lists equated for frequency, to be used for lures in the 2 AFC recognition test.

Procedure:

Within each group, subjects received 4 lists with the appropriate form of testing (Table 9). All lists were presented via taperecorder at 1.5 word/second rate. Prior to the presentation of a list, all subjects were informed as to the type of retention test they would receive following the list presentation. However on the third presentation subjects were informed that they would receive a recognition test, instead of which they received an unexpected recall test. In addition, the subjects were informed as to the nature of the lists they were to hear. Following list presentation subjects in all conditions engaged in the multiplication of 4 digit numbers given verbally by the experimenter for 1 minute. Then subjects were given either a 2 minute recognition test or were allowed 2 minutes for free recall. For the recall test, subjects were instructed to write down, in any order, all the words they could remember from the presented list. In the recognition tests, subjects were informed that one of each of the 60 word pairs was from the previous list and the other word of the pair had not been seen previously in this experiment. The subjects were to indicate, by circling, which

TABLE 9

Presentation Order for Groups I, II, III

Groups	List positions 1	2	3	4
I Mixed Language	Expected Recall	Expected Recognition	Unexpected Recall	Expected Recall
II Synonym	Expected Recall	Expected Recognition	Unexpected Recall	Expected Recall
III Bilingual Translations	Expected Recall	Expected Recognition	Unexpected Recall	Expected Recall

member of each written pair was the old item.

Results and Discussion:

Recall scores for the three recall groups are given in Table 10 . Scores are expressed as percentage correct recall.

Analysis of variance of list means across list positions within each group (unrelated mixed language, synonym and bilingual) was significant: F (2,58) = 30.7, $p < .001$; F (2,80) = 8.9 $p < .001$ and F (2,56) = 49.7, $p < .001$ respectively (See Appendixes 13.1, 13.2, 13.3).

Individual comparisons of means for lists using Duncan's Multiple Range Statistic (Winer 1968, p. 185) indicated that in Group I, the unrelated mixed language condition, the first and fourth list (expected recall) did not differ significantly from each other. Both, however, were significantly different from the third list (unexpected recall). See Appendix 14.1 .

Group II, the synonym condition, reported similar findings. That is the first and fourth list (expected recall) did not differ significantly from each other. Both were significantly different from the third list (unexpected recall). See Appendix 14.2 .

TABLE 10

Proportion of Words Recalled and Recognized from Experiment 3

Groups	LISTS 1 Recall	2 Recognition	3 Unexpected Recall	4 Recall
I (Mixed Language Unrelated)	.14	.74	.06	.12
II (Synonym)	.13	.76	.08	.11
III (Translation)	.27	.83	.12	.18

Individual comparisons of means for lists in Group III, the bilingual translation condition, indicated that all lists were significantly different. That is, List I, II and III were all significantly different from one another (Appendix 14.3).

The List X Group Interaction indicated that the interaction was significant. F (2,4) - 12.5, $p < .001$. Duncan's Multiple Range Statistic indicated Group III was significantly different from Group I and II on List I (Appendix 15 & 16).

However, the overall results indicated that all three kinds of lists, synonym, bilingual and unrelated were significantly affected by the unexpected recall condition (Figure 5).

Analysis of variance between groups shows that the three groups differed significantly. That is, on expected recall, recognition and unexpected recall , all three conditions (mixed language, synonym and bilingual) differed from one another: F (2,99) = 49.8, $p < .001$, F (2,99) = 8.8, $p < .001$ and F (2,99) = 12.7, $p < .001$ respectively (Appendixes 17.1 17.2,17.3).

Duncan's Multiple Range Statistic indicated the Group I (unrelated mixed language) and Group II (synonym) did

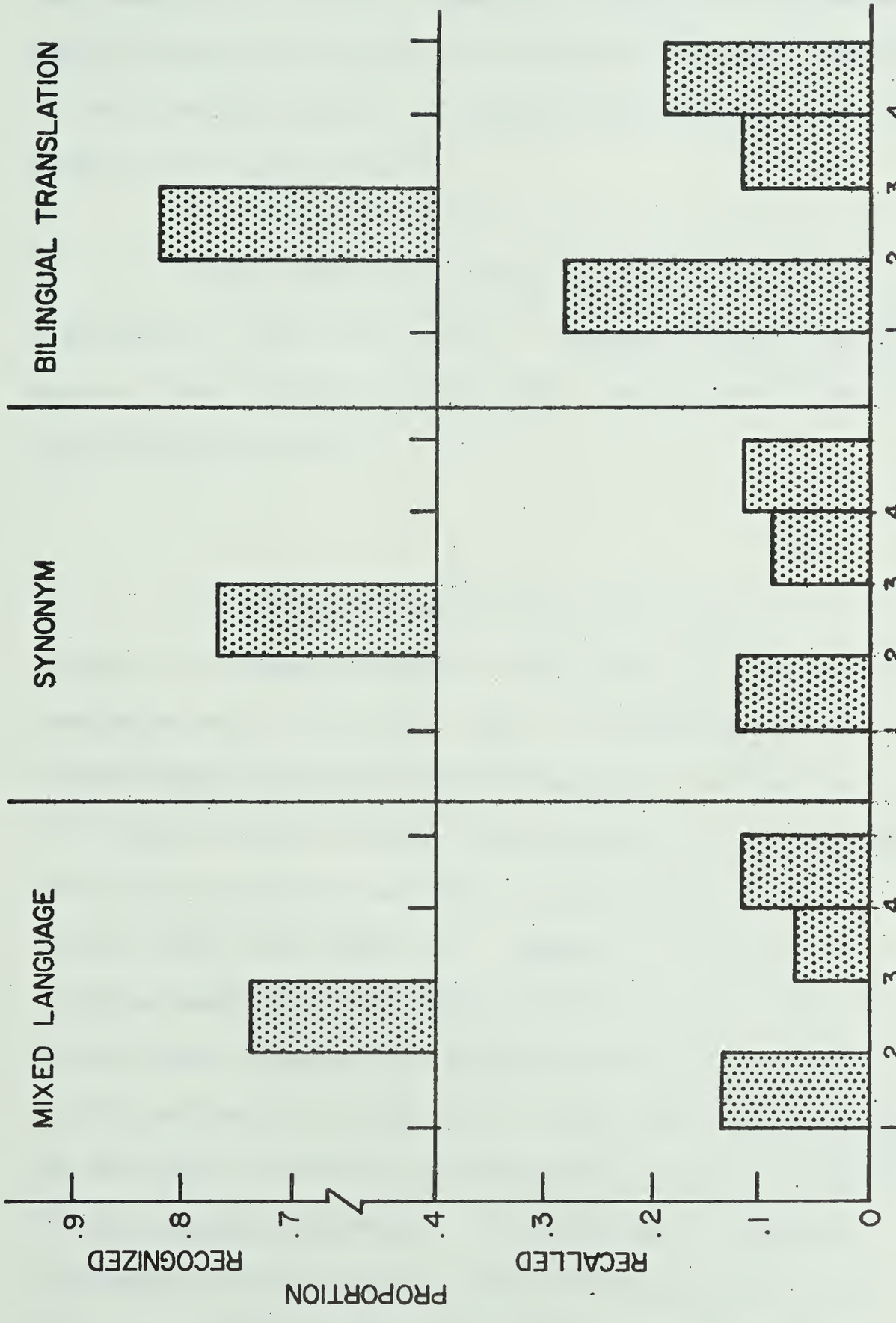
MIXED LANGUAGE
SYNONYM
BILINGUAL TRANSLATION
RECOGNIZED
RECALLED
PROPORTION
.9
.8
.7
.4
.3
.2
.1
0
1
2
3
4
LIST POSITIONS

FIGURE 5

not differ from one another on expected recall, recognition and unexpected recall. However, Group III (bilingual) was significantly different at .05 level from both Group I and II on expected recall, recognition and unexpected recall (Appendixes 18.1,18.2,18.3).

Thus, while the three language conditions performed similarly on expected recall, recognition and unexpected recall, the bilingual conditions' overall performance was significantly better.

The findings of the present study indicate that providing list information prior to recall did not affect the unexpected recall condition. That is, the subjects in all three language conditions were informed about the kind of list they were about to hear. Hence subjects in the translation and synonym conditions were aware of the organizational possibilities within their list. However, all three language conditions showed depressed recall scores in the unexpected recall situation thus supporting the Craik & Tulving (1975) position that factors such as study time, intentionality of the subject, intralist similarity and so on are not crucial for the subject's performance. While the overall superior performance of the bilingual lists could be explained by the interrelationships of the items in the list, and, since the samd advantage was also present in the synonym condition, it would follow that the synonym condition should show the same

performance as the bilingual condition, which was not the case. This finding is inconsistent with the position that providing explicit encoding strategies is advantageous for recall (Tversky, 1973, Griffiths, 1975).

On the other hand, if one accepts the levels of processing view that encoding processes are influenced by expectations about the type of retention test anticipated, then the performance on the unexpected retention test should have been the same for all three language conditions. Although the three language conditions were significantly affected by the unexpected recall condition, it remains unclear why the bilingual translation condition was superior to the synonym condition throughout all recall conditions. A levels of processing approach would predict the same performance for both the bilingual and synonym condition due to the similarity between the two stimulus conditions.

An alternative approach that is compatible with the levels of processing is suggested by Kolers (1975). In general terms, while Kolers accepts the levels of processing position on the importance of the role of practice and the effect of unusual processing in subsequent retention, he rejects the qualitative basis for depth of processing effects and the emphasis given to semantic processing. For Kolers it is the actual operation undertaken during processing of the stimulus event which is crucial for subsequent retrieval. Therefore,

practice could eventually overcome any advantage resulting from habitual use of semantic processing. Thus for Kolers, knowledge of operations represents a plausible alternative to semantic analysis as the substance of memory.

The findings of this study tend to support Kolers (1975) position. That is, if semantic processing is superior to knowledge of operations then both the bilingual translation condition and the synonym condition should have shown the same level of performance. However, subjects performed better with bilingual material which could be due to the fact that they were aware of the translation processes used. That is, the form of coding most suitable for a bilingual list is translation and thus subjects recall not only the meaning of many of the words, they also recall the operation necessary to retrieve the items, in this instance, a translation. On the other hand, in the synonym condition, the operations are not highly practiced compared to the translation operation and therefore recall performance does not match the bilingual condition.

In summary, while the levels of processing position explains the results obtained in the unexpected recall situation, it does not adequately explain the better performance of the bilingual translation condition. In addition, the results seem more consistent with Kolers (1975) notion that procedure, operation and activity affect retention.

Summary and Concluding Discussion

The experimental results will first be briefly summarized. Experiment I showed that over 5 trials bilingual and synonym lists are acquired more slowly than an unrelated list. However, both synonym and translated lists showed the same proportional loss of information during a 24 hour delay, and both were superior to the unrelated unilingual condition.

Experiment II showed that when translations and synonyms are included within a list, rather than between the lists as in experiment I, then both the synonym and bilingual lists are acquired more rapidly than an unrelated unilingual list. The delayed recall test in this experiment showed that the three kinds of lists showed the same proportional loss of information over time.

There are two possible criticisms of the design with respect to both these experiments. In the first instance, it could be argued that synonym and bilingual tests are very similar to categorized lists and therefore to compare an unrelated unilingual list with these lists leads to an unfair comparison. In the second instance, both the bilingual and synonym condition should have performed better in the second experiment because there was a within-list advantage for both these conditions which did not exist in the unrelated condition. In the first

experiment one could argue that the inferior acquisition of these lists was due to the increased number of words that had to be processed compared to the unilingual condition. That is, in the first experiment over the 5 trials, subjects processed 25 words in the unilingual condition compared to 50 words in the bilingual and synonym condition. However in the second experiment over the 5 trials, subjects processed 30 words in the unilingual condition compared to 15 words in the bilingual and synonym conditions thus leading to a criterion problem.

The proportional loss of information during the delay interval, however, is inconsistent with this view. In the first experiment the bilingual and synonym conditions performed better than the unilingual condition whereas in the second experiment the three lists (bilingual, synonym and unilingual) showed the same proportional loss of information. If one accepts the premise that both the bilingual and synonym conditions were handicapped in the first experiment and were facilitated in the second experiment,then one would predict a superior performance on the delayed recall for the bilingual and synonym condition in the second experiment. The results, however, do not support this premise.

Experiment III showed that in a testing situation where subjects are anticipating one form of a retention test and receive another, subjects perform in the same way regardless

of the material being presented. That is, all three lists, (an unrelated mixed language list, a synonym list and a bilingual list) showed a significant drop in performance on the unexpected recall test. Further analysis revealed that the synonym lists and the unrelated mixed language lists did not differ in performance over all conditions. On the other hand, the bilingual lists performed significantly better than the synonym and unrelated mixed language lists throughout the experiment.

Storage Issues

The dual store hypothesis maintains that bilingual memory processes are best described by separate language stores with rapid translation processes (Tulving & Colotla, 1970 ; McNamara & Kushnir, 1971). If this were the case, then synonym information should have performed differently than either translations or mixed language information throughout the three experiments. Thus in the first two experiments, synonym performance should have been superior to translation performance since the subjects were not required to discriminate between languages at recall. In addition in the third experiment the synonym condition should have shown greater superiority compared to the mixed language condition, again since there was no need to discriminate between languages at recall. Given that the synonym information did not show the predicted superiority,it seems reasonable to conclude that a dual store hypothesis does not adequately explain the inferior performance of bilingual information found in previous studies.

A second hypothesis holds that bilingual memory processes can best be viewed as a single store memory with strongly associated language tags and variable search strategies (Liepmann & Saegert, 1974).

This position would predict that inferior acquisition

of bilingual information is due to the relative difficulty of discriminating language tags within a single-store memory. Therefore in the third experiment, the mixed language condition should have shown the poorest performance, followed by the translation condition and with the synonym condition showing the best performance since subjects did not have to discriminate language tags. The results indicate that, on the contrary, the unmixed language condition and the synonym condition showed the same performance, while the translation condition was significantly better than the two other conditions.

In summary, the similar performance of bilingual and synonym information in the first two experiments is incompatible with the separate store hypothesis. In addition the similar performance of the synonym information and the mixed language information in experiment III challenges the position that the inferior performance of bilingual information is due to the relative difficulty in discriminating between language tags at time of recall.

An alternative interpretation is the levels of processing model. The main emphasis in this approach is that various features are extracted from a stimulus through serial stages of analysis, with the graphemic the earliest stage and the semantic, the last. Processing is influenced by task demands, familiarity or novelty of stimulus materials and the type of expected retention test.

One implication of this position is that a form of coding may be selected to suit the task situation and the event of presentation itself is coded as an episode. Therefore in the third experiment subjects focused on the task demands of the situation rather than on any features in the lists, resulting in inferior performance for the three kinds of lists on the unexpected recall test.

A second implication is that elaboration encoding makes material more distinctive from other material so that it is more easily retrieved (Craik & Tulving, 1975). Elaboration encoding enables the subject to retrieve the to-be-recalled item by providing enough features or attributes to distinguish it from other related but not-to-be recalled items. In addition, items may not only be elaborated by being coded in terms of a number of attributes which the subjects extract, they may also be elaborated by features being added to them. Therefore, in a testing situation where few features need be noted, little time is taken up at storage and retrieval since little transformation of the material has to occur. On the other hand, in a situation where the stimulus materials are novel, more transformations take place leading to better retention since the emphasis is on the qualitative nature of processing rather than the quantitative nature of processing. In Experiment I, subjects were required to match features between lists for both the synonym and bilingual

condition, leading to slower acquisition and better retention for this information. In the second experiment few transformations were required since the crucial features were included within the list resulting in rapid acquisition and the same amount of retention as the unrelated unilingual condition.

However, the levels of processing model has some weaknesses. Herriott (1974) maintains that the levels of coding analogy does not necessarily imply an invariable fixed order of coding from less deep, physical, to deeper semantic forms. Rather, a form of coding may be selected to suit the task situation. Depth of coding, moreover, may be treated in terms of number of different forms of coding employed in a task as well as in terms of the form of coding employed. According to Kolers (1975) semantically based theories of perception and memory usually propose hierarchical organization of information and in this view the mind is full of knowledge of objects, concepts, ideas, and images which are sorted compared and coded. Kolers (1975) however maintains that the mind can also be viewed as procedure, operation and activity, and knowledge is expressed by the way the mind has learned to sort, organize and analyze. One implication of this position is that the reason subjects performed better with bilingual material in the last experiment is due to the fact that they are aware of the translation processes used. That is, the form of coding most suitable for a bilingual situation is a

translation and thus subjects recall not only the meaning of many of the words, they also recall the operation necessary to retrieve the items, in this instance, a translation.

In conclusion, the results of the three experiments do not favour a separate store hypotheses; instead the retention of language information rather than being qualitatively different from the retention of other features seems to be characterized in the same way by the conceptual structures. Perhaps, it would be more fruitful to perceive bilingual information as analogous to synonym information and to research bilingual information processing from this position.

In addition, certain operations i.e. translation processes may function in a manner which facilitates the organization, retention and retrieval of bilingual information. Similar operations may be present in synonym information, however, since these operations are not practiced they are not evident.

If, as Schank (1973) maintains, there exists a conceptual base into which utterances in natural language are mapped during understanding, then the better performance on the bilinqual lists may be due to a better understanding of the translation operations. On the other hand, the poorer performance on the synonym lists could be accounted for by a lack of understanding of the operations involved in the mastery of these lists, so that the concepts underlying this process require more processing or practice before mapping can occur.

An alternative approach that might clarify these issues would be to have subjects learn some material in paragraph form and in the experimental conditions have them learn the same material either as a translation or a paraphrase of the original material. If operations are more crucial than repetitions for understanding, then both experimental conditions should show better retention than a control condition in which subjects just practised the same material. Such results would imply that in second language learning situations repetition does not ensure mastery of the concepts. On the contrary, providing the material and its translation requires more processing and therefore seems to lead to better understanding.

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APPENDIX 1

Materials prepared for Experiment 1

Synonym and Bilingual Lists

List 1

Synonyms	Words	Translations
monarch	king	roi
woods	forest	forêt
parcel	package	paquet
tradition	custom	coutume
pair	couple	couple
loyal	faithful	fidèle
concealed	hidden	caché
garment	clothing	vêtement
student	pupil	élève
embrace	kiss	baiser
castle	palace	palais
reply	answer	réponse
rug	carpet	tapis
amusing	funny	drôle
small	little	petit
démon	devil	diable
empire	kingdom	royaume
comrad	friend	ami
unsafe	dangerous	dangereux
haven	shelter	abri
scarlet	red	rouge
gem	jewel	bijou
frail	fragile	fragile
chastise	punish	punir
pick	choose	choisir

List 2

Synonyms	Words	Translations
purchase	buy	acheter
ailment	illness	maladie
eliminate	remove	enlever
obligation	duty	devoir
naked	nude	nu
assist	help	aider
writer	author	auteur
shove	push	pousser
legend	tale	conte
wreck	destroy	détruire
infant	baby	bébé
captive	prisoner	prisonnier
unfinished	incomplete	incomplet
thief	robber	voleur
bunny	rabbit	lapin
extend	lengthen	allonger
liberal	generous	généreux
prophecy	predict	prédire
lease	rent	louer
sleek	smooth	lisse
ideal	perfect	parfait
peril	danger	danger
remote	isolated	isolé
seaman	sailor	matelot
wretched	miserable	miserable

Synonym and Bilingual Lists

List 3			List 4		
Synonyms	Words	Translations	Synonyms	Words	Translations
tranquil	quiet	tranquille	battle	war	guerre
fix	repair	réparer	present	gift	cadeau
center	middle	milieu	bother	disturb	déranger
cushion	pillow	oreiller	good-looking	handsome	beau
prudent	discreet	discret	story	novel	roman
ancient	old	vieux	barrister	lawyer	avocat
conclusion	end	fin	depart	leave	partir
merit	deserve	mériter	idea	thought	pensée
satisfactory	acceptable	acceptable	remember	recall	rappel
facile	easy	facile	recreation	pastime	passe-temps
penny	cent	sou	vanish	disappear	disparaître
bog	swamp	marais	preserve	protect	protéger
overcome	conquer	conquérir	connect	join	joindre
mutter	murmur	murmure	broad	wide	large
comfort	soothe	soulager	mix	stir	mélanger
border	edge	bord	pistol	revolver	revolver
container	vessel	vaisseau	holy	sacred	sacré
possess	have	avoir	pasture	meadow	pré
error	mistake	faute	ocean	sea	mer
observe	notice	remarquer	shout	yell	crier
relish	enjoy	jouir	journey	voyage	voyage
grasp	seize	saisir	shook	trembled	trembler
noble	gallant	gallant	artist	painter	peintre
coarse	rough	rude	ready	prepared	préparé
dim	pale	pâle	pathetic	sad	triste

Unilingual English and French Lists

English		French	English		French
wedding	-	noce	coffee	-	café
sister	-	soeur	garden	-	jardin
feather	-	plume	evening	-	soirée
thunder	-	tonnerre	elbow	-	coude
hammer	-	marteau	circle	-	cercle
corner	-	coin	spider	-	araignée
orchard	-	verger	ribbon	-	ruban
leather	-	cuir	ticket	-	billet
widow	-	veuve	merchant	-	marchand
hunter	-	chasseur	nothing	-	rien
wisdom	-	sagesse	body	-	corps
honey	-	miel	arrow	-	flèche
whistle	-	siffler	shepherd	-	berger
perfume	-	parfum	today	-	aujourd'hui
farmer	-	fermier	pocket	-	poche
basket	-	panier	window	-	fenêtre
anger	-	colère	pepper	-	poivre
sugar	-	sucre	summer	-	été
butter	-	beurre	city	-	ville
island	-	isle	husband	-	mari
forget	-	oublier	shiver	-	frisson
butcher	-	boucher	needle	-	aiguille
chapter	-	chapitre	room	-	chambre
powder	-	poudre	turkey	-	dinde
button	-	bouton	soldier	-	soldat

APPENDIX 2

Instructions for Experiment I

In this experiment you will hear different lists of words repeated five times. The words are very ordinary, for example, dog, cabin, ocean. You will hear a unilingual French list, a unilingual English list, a bilingual list and a synonym list. Each list has 25 words and will be presented in a new order in each of the five times. You will hear 6 lists in all.

First, you will hear a bilingual list(or synonym list). The list will be presented in English. You are to listen attentively to the list. After you have heard the list pick up your pencils and write down as many words as you can remember in any order. Put your pencils down. Then I will play the same list of words again but this time they will be in French and in a different order. You are to listen attentively to the list. After you have heard the list pick up your pencils and write down as many words as you can remember in any order and in either language. This procedure will be repeated 3 more times after which I will present you with a different kind of list. Any questions?

Appendix 3

ANOVA Summary Tables for Group Differences in Recall in Experiment 1. All lists, all trials and all lists, trial 5

APPENDIX 3.1

ANOVA Summary Table for Group Differences, all trials

SOURCE	SS	DF	MS	F	P
TOTAL	13163.788	1079.	12.200		
BETWEEN	4940.463	53.	93.216		
A (GROUPS)	2.356	1.	2.356	0.0248	0.8755
ERROR (S/A)	4938.107	52.	94.964		
WITHIN	8223.325	1026.	8.015		
B (LIST)	825.781	3.	275.260	29.4913	0.0***
AB	285.002	3.	95.001	10.1784	0.0000***
ERROR	1456.042	156.	9.334		
D (TRIALS)	3135.466	4.	783.867	235.3522	0.0***
AD	3.217	4.	0.804	0.2414	0.9146
ERROR	692.767	208.	3.331		
BD	449.652	12.	37.471	17.8112	0.0***
ABD	62.635	12.	5.220	2.4810	0.0035
ERROR	1312.763	624.	2.104		

***$p < .001$

APPENDIX 3.2

ANOVA Summary Table for Group Differences, Trial 5 only

SOURCE	SS	DF	MS	F	P
TOTAL	2754.940	215.	12.814		
BETWEEN	1486.065	53.	28.039		
A (GROUPS)	1.603	1.	1.603	0.0561	0.8136
ERROR	1484.462	52.	28.547		
WITHIN	1268.875	162.	7.833		
D (TRIALS)	470.347	3.	156.782	33.7613	0.0000***
AD	74.086	3.	24.695	5.3179	0.0016
ERROR	724.442	156.	4.644		

*** $p < .001$

APPENDIX 4

ANOVA Summary Tables for Acquisition in Recall in Experiment I All list, all trials. List Effects, Trial Effects

APPENDIX 4.1

ANOVA Summary Table for Main Effects of Lists. All Trials

SOURCE	SS	DF	MS	F	P
T (TRIALS)	3135.5	4	783.87		
L (LISTS)	825.78	3	275.26		
TL	449.65	12	37.471		
S	4940 5	53	93.216		
TS	695.98	212	3.2829		
LS	1741.0	159	10.950		
TLS	1375.4	636	2.1626		
TOTAL	13164.	1079			
F-VALUES AND PROBABLITIES FOR SPECIFIED TEST					
T (TRIALS)	3135.5	4	783.87	238.7695	0.0000****
ERROR TS	695.98	212	3.2829		
L (LISTS)	825.78	3	275.26	25.1380	0.0000***
ERROR	1741.0	159	10.950		
TL	449.65	12	37.471	17.3270	0.0000***
ERROR TLS	1375.4	636	2.1626		
T	3135.5	4	783.87	207.0476	0.0000***
L	825.78	3	275.26	72.7061	0.0000***
TL	449.65	12	37.471	9.8975	0.0000***
ERROR TS+LS+TLS	3812.4	1007	3.7859		

*** $p < .001$

APPENDIX 4.2

ANOVA Summary Table for Main Effects of Lists, Trial 5

SOURCE	SS	DF	MS	F	P
L (LISTS)	470.35	3	156.78		
S (SUBJECTS)	1486.1	53	28.039		
LS	798.53	159	5.0222		
TOTAL	2754.9	215			

F-VALUES AND PROBABILITIES FOR SPECIFIED TESTS

L (LISTS)	470.35	3	156.78	31.2179	0.0000 ***
ERROR LS	798.53	159	5.0222		

*** $p < .001$

APPENDIX 5

ANOVA Summary Table for Recall on Trial 5 and Delayed Recall Interactions

APPENDIX 5.

ANOVA Summary Table for Recall on Trial 5 and Delayed Recall Interactions

SOURCE	SS	DF	MS	F	P
TOTAL	7782.444	375	20.753		
BETWEEN	2311.632	46	50.253		
A (GROUPS)	35.142	1.	35.142	0.6947	0.4090
ERROR	2276.489	45.	50.589		
WITHIN	5470.813	329.	16.629		
B (LISTS)	560.029	3.	186.676	22.5480	0.0000 ***
AB	111.860	3.	37.287	4.5037	0.0048
ERROR	1117.673	135.	8.279		
D (DAYS)	2617.191	1.	2617.191	375.8288	0.0000 ***
AD	0.001	1.	0.001	0.0001	
ERROR	313.370	45.	6.964		
BD	225.745	3.	75.248	19.6836	0.0000 ***
ABD	8.854	3.	2.951	0.7720	0.5116
ERROR	516.089	135.	3.823		

*** $p < .001$

APPENDIX 6

Duncan's Multiple Range Comparisons between Ordered Means, Experiment I, Trial 5; Trial 5 and Delayed Recall

APPENDIX 6.1

Duncan's Multiple Range Comparisons between Ordered Means.

Trial 5

	Ordered Means			
	Synonym Lists	Bilingual Lists	Unilingual French	Unilingual English
Means	8.3	9.3	9.9	10.7
8.3	-	1.0	1.6	2.4
9.3		-	.6	1.4
9.9				.8
10.7				-
	r=	2	3	4
q(r,135)		2.8	3.36	3.69

	Synonym Lists	Bilingual Lists	Unilingual French	Unilingual English
Means	8.3	9.3	9.9	10.7
8.3	-	*	*	*
9.3		-	*	*
9.9			*	*
10.7			-	

$p < .05$

APPENDIX 6.2

Duncan's Multiple Range Comparisons between Ordered Means: Trial 5 and Delayed Recall

	Synonym	Bilingual	Unilingual English	Unilingual French
	3.6	3.9	6.0	7.4
3.6	-	.3	2.4	3.8
3.9		-	2.1	3.5
6.0			-	1.4
7.4				-

	r=	2	3	4
q(r,135)		3.7	4.2	4.5

	Synonym	Bilingual	Unilingual English	Unilingual French
	3.5	3.9	6.0	7.4
3.5		-	*	*
3.9			*	*
6.0				*

* p .05

APPENDIX 7

Materials prepared for Experiment II

Word Lists Used in Experiment II

Bilingual Lists

List 1	List 2
duty	writer
happy	dangerous
nude	kingdom
disappear	hidden
collect	vessel
bucket	rough
mix	surprise
movie	rent
event	incomplete
particle	smooth
push	swamp
clothing	predict
repair	lengthen
devoir	jewel
heureux	prisoner
nu	incomplet
disparaître	louer
collectionner	surprise
seau	rude
mélanger	vaisseau
évènement	caché
particule	royaume
pousser	dangereux
vêtement	prisonnier
réparer	bijou
carpet	allonger
buy	auteur
cinema	prédire
acheter	marais
tapis	lisse

Word Lists Used in Experiment II

Unilingual Unrelated Word Lists

List 1	List 2
wedding	coffee
sister	garden
feather	evening
thunder	elbow
hammer	circle
corner	spider
orchard	ribbon
leather	ticket
widow	merchant
hunter	nothing
wisdom	body
honey	arrow
whistle	shepherd
perfume	today
farmer	pocket
basket	window
anger	pepper
sugar	summer
butter	city
island	husband
forget	shiver
butcher	needle
chapter	room
powder	turkey
button	soldier
mischief	cannon
leather	silver
guilty	velvet
squirrel	column
yellow	

Synonym
Word Lists Used in Experiment II

List 1	List 2
duty	coarse
film	shook
happy	writer
incident	dangerous
speck	amaze
nude	lease
shove	cargo
revolve	unfinished
disappear	enlist
garment	defect
collect	swamp
fix	kingdom
bucket	error
stir	hidden
obligation	vessel
movie	rough
cheerful	trembled
event	author
particle	unsafe
naked	surprise
push	rent
rotate	freight
vanish	incomplete
clothing	enroll
gather	fault
repair	bog
pail	empire
mix	mistake
rug	concealed
carpet	container

APPENDIX 8

Instructions for Experiment II

In this experiment you will hear 2 different lists of words repeated five times. The words are very ordinary, for example, dog, cabin, ocean. You will hear 2 unilingual English lists and 2 bilingual lists (or 2 synonym lists). Each list has 30 words and will be presented in a new order in each of the five times. You will hear 4 lists in all.

First, you will hear a bilingual list (or a synonym list). Half of the words will be in English words. You will hear 15 words and 15 translations. However the words will be mixed within the list so that you do not hear 15 English words and then 15 French words. You are to listen attentively to the list. After you have heard the list pick up your pencils and write down as many words as you can remember in any order. Then, put your pencils down and I will play the same list of words again but this time they will be in a new order. You are to listen attentively to the list. After hearing the list pick up your pencils and write down as many words as you can remember in any order. This procedure will be repeated 3 more times after which I will present you with a different kind of list. Any questions?

APPENDIX 9

ANOVA Summary Tables for Multi-Trial Free Recall

Trials 1-5 Experiment II Bilingual, Synonym and Unrelated Unilingual Lists

Main Effects for Trials and Lists

APPENDIX 9.1

ANOVA Summary Table for Group I:

Bilingual Lists and Unrelated Unilingual Lists

Main Effects of Trials and Lists

SOURCE	SS	DF	MS	F	P
T (TRIALS)	2487.9	4	621.96		
L (LISTS)	1191.5	1	1191.5		
TL	27.224	4	6.8060		
S	1227.0	22	55.773		
TS	255.20	88	2.9000		
LS	272.94	22	12.407		
TLS	178.93	88	2.0332		
TOTAL	5640.7	229			

F-VALUES AND PROBABILITIES FOR SPECIFIED TESTS

T	2487.9	4	621.96	174.1690	0.0000***
L	1191.5	1	1191.5	333.6650	0.0000***
TL	27.224	4	6.8060	1.9059	0.1109
ERROR LS+TS+LTS	707.06	198	3.5710		

***p < .001

APPENDIX 9.2

ANOVA Summary Table for Group II: Synonym Lists and Unrelated Unilingual Lists

Main Effects for Trials and Lists

SOURCE	SS	DF	MS	F	P
T(TRIALS)	945.91	4	236.48		
L (LISTS)	26.133	1	26.133		
TL	50.672	4	12.668		
S	628.90	26	24.188		
TS	201.14	104	1.9340		
LS	182.47	26	7.0179		
TLS	96.478	104	0.92767		
TOTAL	2131.7	269			

F-VALUES AND PROBABILITIES FOR SPECIFIED TESTS

T (TRIALS)	945.91	4	236.48	115.2636	0.0000***
L (LISTS)	26.133	1	26.133	12.7378	0.0004***
TL	50.672	4	12.668	6.1746	0.0001***
ERROR LS+TS+LTS	480.08	234	2.0516		

***$p < .001$

APPENDIX 9.3

ANOVA Summary Table for Group III:
Synonym Lists and Unrelated Unilingual Lists
Main Effects for Trials and Lists

SOURCE	SS	DF	MS	F	P
T (TRIALS)	3257.4	4	814.36		
L (LISTS)	1224.0	1	1224.0		
TL	93.391	4	23.348		
S	1890.4	37	51.092		
TS	392.07	148	2.6492		
LS	16649	37	4.4997		
TLS	250.61	148	1.6933		
TOTAL	7274.4	379			

F-VALUES AND PROBABILITIES FOR SPECIFIED TESTS

T	3257.4	4	814.36	335.1331	0.0000***
L	1224.0	1	1224.0	503.7183	0.0000***
TL	93.391	4	23.348	9.6083	0.0000***
ERROR LS TS LTS	809.17	333	2.4299		

***$p < .001$

APPENDIX 10

ANOVA Summary Tables for Interaction Between Trial 5 and Delayed Recall, Experiment II, Bilingual, Synonym and Unrelated Unilingual Lists

APPENDIX 10.1

ANOVA Summary Table for Interaction Between Trial 5 and Delayed Recall Group I : Bilingual and Unrelated Unilingual Lists

SOURCE	SS	DF	MS	F	P
L (LISTS)	486.22	1	486.22		
S (SUBJECTS)	590.90	22	26.859		
LS	136.97	22	6.2258		
T (TRIALS)	3222.6	1	3222.6		
LT	6.5245	1	6.5245		
ST	123.58	22	5.6171		
LST	44.163	22	2.0074		
TOTAL	4611.0	91			
F-VALUES AND PROBABILITIES FOR SPECIFIED TESTS					
T(TRIALS)	3222.6	1	3222.6	698.0239	0.0000***
L	486.22	1	486.22	105.3162	0.0000***
TL	6.5245	1	6.5245	1.4132	0.2388
ERROR	304.71	66	4.6168		
LS TS LTS					

*** $p < .001$

APPENDIX 10.2

ANOVA Summary Table for Interaction Between Trial 5 and Delayed Recall. Group II, Synonym and Unrelated Unilingual Lists

SOURCE	SS	DF	MS	F	P
L (LISTS)	68.481	1	68.481		
S (SUBJECTS)	414.77	26	15.953		
LS	105.77	26	4.0680		
T (TRIALS)	1020.6	1	1020.6		
LT	5.3333	1	5.3333		
ST	82.907	26	3.1887		
LST	38.167	26	1.4679		
TOTAL	1736.0	107			
F-VALUES AND PROBABILITIES FOR SPECIFIED TESTS					
T	1020.6	1	1020.6	350.9316	0.0000***
L	68.481	1	68.481	23.5474	0.0000***
TL	5.3333	1	5.3333	1.8339	0.1796
ERROR LS+TS+LTS	226.84	78	2.9082		

***p < .001

APPENDIX 10.3

ANOVA Summary Table for Interaction Between Trials and Delayed Recall Group III: Synonym and Unrelated Unilingual Lists

SOURCE	SS	DF	MS	F	P
S (SUBJECTS)	861.36	37	23.280		
L (LISTS)	987.87	1	987.87		
SL	218.44	37	5.9038		
D (DAYS)	3617.2	1	3617.2		
SD	159.06	37	4.2989		
LD	0.27794	1	0.27794		
SLD	61.785	37	1.6699		
TOTAL	5906.0	151			
F-VALUES AND PROBABILITIES FOR SPECIFIED TESTS					
L	987.87	1	987.87	264.1313	0.0000***
D	3617.2	1	3617.2	967.1631	0.0000***
LD	0.27794	1	0.27794	0.0743	0.7859
ERROR	280.50	75	3.7401		
LS LD LSD					

***p < .001

APPENDIX 11

Test Materials for Experiment III

Unrelated Mixed Language List

List 1

fièvre	tapis	rester
chimney	fountain	noce
battle	éviter	upset
soeur	accuser	eagle
freely	bonbon	ravissant
disturb	peaceful	copy
endormi	manche	fou
cerise	vide	carry
prêter	suffer	conceal
procure	envie	résoudre
atteindre	beauty	learning
author	rapid	presser
repeat	faim	aware
ciel	gracieux	bas
valley	offer	colère
prisonnier	extrême	slumber
defend	verger	imposer
aiguille	stolen	shaken
madam	tonneau	kitten
create	perceive	owner

List 2

servant	bitter	adopt
castle	oisif	insulter
failure	horror	survivre
palais	roman	shallow
triumph	parfum	kindness
blessing	col	sagesse
remplacer	victim	cotton
huître	théâtre	montagne
méchant	expliquer	bottom
condemn	sentence	oven
chapelle	maladie	pâturage
weakness	contrast	review
legend	handsome	berger
jouir	noble	regard
allow	pomme	chanceler
bijou	lady	opéra
awake	bébé	twinkle
douche	punir	déclarer
robber	proceed	écho
	diable	disguise
		affair

List 3

tigre	learning	détruire
fameux	contrast	shallow
failure	veuve	writer
freely	expliquer	judgement
poudre	forêt	bas
blessing	ancien	chanceler
plume	funeral	opéra
procure	doigt	player
treasure	offer	flèche
pupil	extrême	panier
destroy	lady	écho
douche	proceed	montagne
oisif	préserver	widow
éviter	rester	advice
ugly	powder	regard
conclude	survivre	funérailles
riches	adopt	tonnerre
accuser	singe	separate
collar	trésor	conceal
bitter	pâturage	owner

List 4

endormi	peaceful	élève
preserve	princess	presser
rocky	manche	mirror
huitre	avis	upset
stable	envie	kindness
méchant	noble	laide
monkey	gracious	conclure
awake	punir	richesses
create	charming	cotton
horror	séparer	imposer
miroir	tiger	déclarer
écrivain	famous	apprentissage
jugement	tonneau	princesse
allow	rocheuses	review
valley	contrast	aware
blossom	étable	forest
joueur	feather	traître
arrow	ravissant	charmant
basket	fou	oven
suggérer	ancient	finger

APPENDIX

Synonym Lists

List 1		List 2	
ailment	sickness	bind	fasten
bother	disturb	empire	kingdom
repair	fix	hidden	concealed
assign	allocate	collect	gather
sacred	holy	palace	castle
fatal	deadly	acceptable	satisfactory
meadow	pasture	cargo	freight
secured	obtained	grasp	seize
motor	engine	coarse	rough
hurry	hasten	attempt	try
rash	reckless	slender	slim
modify	alter	acquire	gain
journey	voyage	confuse	confound
sea	ocean	dangerous	unsafe
connect	join	missing	absent
trembled	shook	confine	restrict
revolver	pistol	haven	shelter
kiss	embrace	film	movie
stir	mix	powerless	helpless
pail	bucket	cushion	pillow
ready	prepared	surrender	submit
woods	forest	expensive	costly
broad	wide	argue	debate
appropriate	suitable	cordial	friendly
protect	preserve	squeak	creak
disappear	vanish	revolve	rotate
speck	particle	enlist	enroll
purchase	buy	hunt	pursue
artist	painter	clatter	rattle
shout	yell	garment	clothing

Synonym Lists

List 3

swamp	bog
devil	demon
package	parcel
foolish	silly
naked	nude
vessel	container
brutal	savage
overcome	conquer
shove	push
locate	situate
mutter	murmur
charming	delightful
kingdom	empire
legend	tale
soothe	comfort
destroy	wreck
amaze	surprise
infant	baby
prisoner	captive
clumsy	awkward
drowsy	sleepy
student	pupil
prosper	flourish
unfinished	incomplete
thief	robber
edge	brink
fault	defect
complain	grumble
evil	wicked
enlarge	expand

List 4

glitter	sparkle
nervous	anxious
endless	unlimited
loyal	faithful
attach	affix
extend	lengthen
pastime	recreation
lumber	timber
slope	incline
upright	vertical
liberal	generous
bleak	barren
stormy	turbulent
carpet	rug
error	mistake
miserable	wretched
baggage	luggage
predict	prophecy
rent	lease
author	writer
sleek	smooth
observe	watch
peril	danger
tradition	custom
seaman	sailor
reply	answer
perfect	ideal
fat	obese
cask	barrel
isolated	remote

APPENDIX

Bilingual Translation Lists

List 1

tigre	learning	détruire
fameux	princess	mirror
preserve	veuve	writer
rocky	avis	judgement
poudre	forêt	laide
stable	ancien	conclude
plume	funeral	richesses
monkey	doigt	player
treasure	charming	flèche
pupil	séparer	panier
destroy	tiger	apprentissage
miroir	famous	princesse
écrivain	préserver	widow
jugement	rocheuses	advice
ugly	powder	forest
conclure	étable	ancient
riches	feather	funérailles
joueur	singe	charmant
arrow	trésor	separate
basket	élève	finger

List 2

hunter	lapin	kingdom
beggar	billet	chapter
faute	angle	lys
geler	belief	réparer
elbow	partner	channel
cannot	cradle	spider
lazy	échange	artist (f)
frisson	finir	fidèle
merchant	miel	citron
pocket	hammer	rabbit
royaume	chasseur	ticket
chapitre	mendiant	circle
lily	frozen	angle (f)
repair	mistake	croyance
canal	coude	partenaire
araignée	paresseux	berceau
artists	shiver	exchange
faithful	canoe	finish
lemon	marchand	honey
cercle	poche	marteau

	List 3	
colis	lion	honest
kitchen	cuisine	vessel
suffer	souffrir	chanceux
guilty	coupable	jaune
ruban	garden	rejoice
vertu	prayer	jardin
feeble	silence	négliger
conquête	divine	button
velvet	faible	prière
hidden	velours	divine
butter	caché	event
lawyer	beurre	inventer
honnête	invent	drôle
maître	avocat	fermier
squirrel	funny	parcel
lucky	écureuil	ribbon
vaisseau	farmer	lion
réjouir	bouton	silence
yellow	master	virtue
neglect	évènement	conquest

	List 4	
servant	parfum	verger
chimney	bonbon	théâtre
bataille	replace	vide
sister	condemn	phrase
triomphe	théâtre	devil
remplacer	empty	sickness
cherry	chapel	beauty
borrow	sentence	servant
condamner	jewel	hungry
author	needle	cheminée
chapelle	maladie	apple
heaven	beauté	baby
bijou	carpet	soeur
aiguille	faim	cerise
battle	novel	orchard
robber	pomme	empty
tapis	fontaine	auteur
fountain	bébé	emprunter
triumph	perfume	diable
roman	candy	ciel

APPENDIX 12

Instructions for Experiment III

I. Expected Recall Instructions

In this experiment, you are going to hear 4 lists of words. Each list is made up of 60 randomly chosen common words, half of which will be in English and half of which will be in French (or half will be synonyms of translations). Following the presentation of the list you will be required to perform a multiplication task, after which you are to write down in any order as many words as you can remember from the list you just heard. Any questions?

II. Expected Recognition Instructions

You are now going to hear a second list of words, just like the words you heard in the first list. We will follow the same procedure as previously except this time you will be required to do a recognition test rather than a recall test. You will see a pair of words like this; one of the words will be on the list you just heard. You are to circle the one from the list, if you don't know , guess, but make sure you circle one member of the pair . Any questions?

III. Unexpected Recall

The instructions are the same as the recognition instructions except for the following changes:

Instead of a recognition test, I want you to write down in any order, without guessing, all the words you can remember from the list you just heard. Please begin.

APPENDIX 13.1

ANOVA Summary Table for Recall Group I

Mixed Language Lists

SOURCE	SS	DF	MS	F	P
T (TRIALS)	305.36	2	152.68		
S (SUBJECTS)	285.29	29	9.8375		
TS	287.98	58	4.9651		
TOTAL	878.62	89			

F-VALUES AND PROBABILITIES FOR SPECIFIED TESTS

T	305.36	2	152.68	30.7500	0.0000***
S	285.29	29	9.8375	1.9813	0.0135*
ERROR TS	287.98	58	4.9651		

***p .001

APPENDIX 13.2

ANOVA Summary Table for Group II - Synonym Lists

SOURCE	SS	DF	MS	F	P
T (TRIALS)	131.24	2	65.618		
S	577.84	40	14.446		
TS	583.43	80	7.2929		
TOTAL	1292.5	122			
F-VALUES AND PROBABILITIES FOR SPECIFIED TESTS					
T	131.24	2	65.618	8.9975	0.0003***
S	577.84	40	14.446	1.9808	0.0048**
ERROR TS	583.43	80	7.2929		

***p .001

APPENDIX 13.3

ANOVA Summary Table for Recall Group III - Bilingual Translations

SOURCE	SS	DF	MS	F	P
T (TRIALS)	1122.3	2	561.14		
S	1114.4	28	39.800		
TS	631.06	56	11.269		
TOTAL	2867.7	86			

F-VALUES AND PROBABILITIES FOR SPECIFIED TESTS

T	1122.3	2	561.14	49.7953	0.0000***
S	1114.4	28	39.800	3.5318	0.0000***
ERROR TS	631.06	56	11.269		

***p .001

APPENDIX 14.1

Duncan's Multiple Comparisons between Ordered Means: Group I; between lists

List Positions

	3	4	1
	4.1	7.4	8.4
4.1	-	3.3	4.3
7.4		-	1.0
8.4			-

	r=	2	3
q(2,58)		2.82	3.37

List Positions

	3	4	1
	4.1	7.4	8.4
4.1		*	*
7.4			-
8.4			

* $p < .05$

APPENDIX 14.2

Duncan's Multiple Range Comparisons Between Ordered Means: Group II; Between Lists

List Positions

	3	4	1
	5.1	6.8	7.6
5.1	-	1.7	2.5
6.8		-	.8
7.6			-

	r =	2	3
q(r,80)		2.82	3.37

List Positions

	3	4	1
	5.1	6.8	7.6
5.1		*	*
6.8			-
7.6			

* $p < .05$

APPENDIX 14.3

Duncan's Multiple Comparisons between Ordered Means: Group III; Between Lists

List Position

	3	4	1
	7.4	10.8	16.2
7.4	-	3.4	8.8
10.8		-	5.4
16.2			-

	r-	2.82	3.37

q(r,56)

	3	4	1
	7.4	10.8	16.2
7.4		*	*
10.8			*
16.2			

* $p < .05$

APPENDIX 15

ANOVA Summary Table List X Group Interaction

SOURCE	SS	DF	MS	F	P
A (Groups)	1577.332	2,	788.666	38.686	0.001
S-Within	1977.457	97.	20.386		
B	1304.241	2.	652.121	84.199	0.001
AB	390.175	4.	97.544	12.594	0.001
BS-Within	1502.531	194.	7.745		

***p .001

APPENDIX 16

Duncan's Multiple Comparison between ordered means; Lists X Group Interaction; List 1

	Synonym	Mixed Language	Bilingual Translation
	3.3	3.4	7.8
3.3		.1	4.5
3.4		-	4.4
7.8			-

	r-	2	3
q(r,194)		2.8	3.36

	Synonym	Mixed Language	Bilingual Translation
	3.3	3.4	7.8
3.3		-	*
3.4			*
7.8			

* $p < .05$

APPENDIX 17.1

ANOVA Summary Table for Recall; List 1

Analysis of Variance

SOURCE	DF	SS	MS	F(RATIO)	F PROB.
Between Groups	2	1416.7227	708.3613	49.801	0.000 ***
Within Groups	97	1379.7187	14.2239		
TOTAL	99	2796.4414			

*** $p < .001$

APPENDIX 17.2

ANOVA Summary Tables Between Groups, List 3

SOURCE	DF	SS	MS	F	P
Between Groups	2	177.9868	88.9634	8.850	0.000***
Within Groups	97	975.0637	10.0522		
TOTAL	99	1152.9905			

***p < .001

APPENDIX 17.3

ANOVA Summary Table Between Groups, List IV

SOURCE	DF	SS	MS	F	P
Between groups	2	294.7969	147.3984	12.707	0.000***
Within groups	97	1125.2070	11.6001		
TOTAL	99	1420.0039			

***p < .001

APPENDIX 18.1

Duncan's Mutliple Range Comparisons Between Ordered Means: Between Groups; List 1, Expected Recall

	Synonym	Mixed Language	Bilingual Translation
	7.6	8.4	16.2
7.6	-	.8	8.6
8.4		-	7.8
16.2			-

	r -	2	3
q(r,97)		2.81	2.96

	Synonym	Mixed Language	Bilingual Translation
	7.6	8.4	16.2
7.6		-	*
8.4			*
16.2			

* $p < .05$

APPENDIX 18.2

Duncan's Multiple Comparisons Between Ordered Means: Between Groups; List 3, Unexpected Recall

	Mixed Language	Synonym	Bilingual Translation
4.1	-	1.0	7.4
5.1		-	6.6
714			-

	r =	2	3
q(r,97)		2.81	2.96

	Mixed Language	Synonym	Bilingual Translation
	4.1	5.1	7.4
4.1		-	*
5.1			*
7.4			

* $p < .05$